Official Proceedings

OF THE

Western Railway Club

FOR THE

Club Year 1903-1904

The Club meets the third Tuesday of each month, except June, July and August.
The Club Year ends with the meeting in May.

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular monthly meeting of the Western Railway Club was held on Tuesday, September 15, 1903, President D. F. Crawford in the chair. Meeting called to order at 2:30 p. m.

Among those present the following registered:

Ault, C. B.
Barnum, M. K.
Benjamin, F. G.
Bischoff, G. A.
Bentley, H. T.
Brandt, F. W.
Brazier, F. O.
Broman, J. G.
Bronner, E. D.
Brooke, Geo. D.
Brooks, P. R.
Carney, J. A.
Carpenter, H. C.
Coffin, G. B.
Cooke, Allen.
Cota, A. J.
Crawford, D. F.
Cushing, Geo. W.
Deming, H. V.
Doebler, C. H.
Ducas, C.
Dunham, W. E.
Eames, Ed. J.
Elliott, M. D.
Elliott, P. M.
Fenn, Frank D.
Fogg, J. W.
Forsyth, Wm.
Gaspar, Chas.
Hechler, W. D.
Hill, Jas. W.
Hinson, J. A.
Hogue, O. D.
Hooven, A. E.
Justice, D. J.
Keeler, Sanford.
Kirby, T. B.
Kuhlman, H. V.
Lawes, T. A.
Long, J. H.
McAlpine, A. R.
Menzel, W. G.
Mileham, C. M.
Mylett, Jas.
Nichols, G. P.
Noble, L. C.
Parks, Geo. E.
Patterson, J. B.
Peck, P. H.
Perry, A. R.
Pflager, H. M.
Quayle, R.
Riddell, Chas.
Rogers, M. J.
Rowley, S. T.
Royal, Geo.
Sanborn, J. G.
Schroyer, C. A.
Setchel, J. H.
Sharp, W. E.
Slaughter, G. F.
Smith, F. E.
Stimson, O. M.
Stocks, W. H.
Talmage, J. T.
Taylor, J. W.
Thompson, J. S.
Thurnauer, Gustav.
Tratman, E. E. R.
Walbank, R. T.
Webb, E. R.
Wickhorst, M. H.
Williams, G. H.
Wilson, Geo. L.

THE PRESIDENT: The first order of business is the approval of the minutes of the last meeting. The minutes were published, and if there are no objections, will be approved as printed.

The Secretary has some announcements to make in reference to the membership list:

THE SECRETARY:

Members, May, 1903		1,112
New Members		15
Total		1,127
Resigned	26	
Dues unpaid	39	
Mail returned	2	
Deaths	3	70
Total Membership		1,057

NEW MEMBERS.

NAME. OCCUPATION AND ADDRESS.	PROPOSED BY
Bert Hynes, New York Air Brake Co., Chicago	Geo. Royal.
E. C. Anderson, Chicago, Burl. & Quincy R. R. Co., Chicago	J. S. Goddard.
E. Cockfield, Chicago, Burl. & Quincy R. R. Co., Aurora, Ill.	J. S. Goddard.
E. H. Symington, Railway Appliance Co., Chicago	P. Manchester.
R. L. Huntley, P. A. E., Union Pacific R. R., Omaha, Neb.	J. W. Taylor.
A. E. Johnson, Stkpr., C. & N. W. Ry., Kaukauna, Wis.	J. F. Fleischer.
J. C. Younglove, H. W. Johns-Manville Co., Chicago	F. G. Younglove.
J. S. Ford, Auditor C. & E. I. R. R. Co., Chicago	J. W. Taylor.
E. K. Harris, Damascus Bronze Co., Chicago	J. G. Sanborn.
Stewart McDonald, Fire Inspr., C. & N. W. Ry., Chicago	W. E. Dunham.
Theo. F. H. Zealand, Draftsman, M. C. R. R., Detroit.	G. E. Parks.
H. L. Winslow, J. L. Yale & Co., Chicago	J. N. Reynolds,
W. B. Simpson, A. M. Castle & Co., Chicago	A. M. Castle.
Jno. Moriarity, G. F. L. D., Iowa Central Ry., Marshalltown, Ia.	C. H. Mead.
D. E. Moodie, G. S. K., Wis. Central Ry., Fond du Lac, Wis.	W. G. Menzel.

THE SECRETARY: I have also, Mr. President, the report of the Auditing Committee. It is as follows:

CHICAGO, September 15, 1903.

To the President and Board of Directors:

We, the Auditing Committee, have examined the books of Secretary and Treasurer for fiscal year ending May 31, 1903, and find same to be correct.

A. J. COTA, }
GEO. ROYAL, } Committee.

The President: If there is no other new business to come before the meeting we will proceed with the reading of Mr. Henderson's paper on "Water Treatment in Railroad Operation."

Mr. George R. Henderson: Mr. President, this is not intended by any means as an essay on water treatment, but merely to call attention to some facts and peculiarities in connection with water treatment which are sometimes overlooked when the plant is being figured upon and installed, and which sometimes make themselves manifest in a very unpleasant way after the construction has been completed; and the intention was more to start a little criticism, or family talk, as it were, on the subject of water purification and what its difficulties are, and how it should be accomplished. I wish to make these few words of explanation so as not to be criticised in any way as intending an exposé of the subject.

WATER TREATMENT IN RAILROAD OPERATION.

By Mr. G. R. Henderson.

Few improvements in railroad operation have excited such uniform interest within the last few years as the systematic treatment of boiler feed waters. The inauguration of this work is of very recent origin. In the struggle for competitive mastery, every point of vantage is discussed, and if it be possible to maintain our engines longer in service or reduce the cost of repairs by any legitimate means, it is sure to receive attention. When our engines were small and not worked to anything like their capacity, a little additional "mud" in the boiler was not given serious thought. When, however, our boilers came to be operated for long hours to their limit of evaporative capacity, the question became a serious one, and the more so as the engine was needed for almost continuous service.

"Washout experts" came to the front and contended that by extreme care—so difficult to enforce among the exigencies of traffic congestion—boilers could be maintained a long time in service; the very delays due to holding the engine for such careful washouts would sum up, perhaps, more time actually out of service than would ordinarily be imagined.

The next step was to use soda ash in the tender, and so make a treating plant out of the locomotive, necessitating frequent and thorough washing out and blowing out—the latter particularly objectionable in passenger service. Often soda ash was used when the incrustants were carbonates and really needed a simple treatment of lime, but "soda ash" was a standard "cure all," and in it went.

Finally it became evident that better service could be maintained by treating the water before it was taken on the tender, and thus avoid the blowouts and washouts and their various objections. The principal stumbling block was the expense of plants, which runs from one to six thousand dollars each, and if bad waters are numerous many such plants will be required.

In order to demonstrate the efficiency of such systems, one western road covered a stretch of 200 miles in a bad water district by treating tanks so located that the passenger engines would use only treated water, the stations being separated by 50-mile intervals. The freights, taking water much more frequently, were not expected to show the same benefit as the passenger engines. In the course of a few months the passenger power showed by inspection that the old scale was dropping off the firebox sheets and staybolts and that the treatment was becoming effective.

The different waters were doctored with lime or soda ash, or both, as analysis of the water indicated necessary, but the engineers reported increased trouble from foaming, and further analyses proved that they were correct.

As a rule boiler waters are found objectionable if containing ingredients that will cause corrosion, incrustation or foaming. Corrosive matter can generally be neutralized, but foaming troubles are difficult to overcome. Oil, tannic acid, liquid hemlock and various boiler compounds have been experimented with, and perhaps the best results have been obtained with the Omaha boiler compound, which seems to quiet the water very effectively without injuring the boiler. If a water contains over 50 grains of foaming matter (soluble salts) to the gallon, it is sure to give trouble in a locomotive.

The incrusting salts must be regarded as of two kinds: carbonates and sulphates. The former, when boiled, give off carbonic acid gas when in excess, and deposit as chalk in a soft, flocculent mass, easily blown out of the boiler. By a previous treatment of slaked lime, the carbonic acid is all combined with lime, allowing the carbonates to deposit while cold in the treating tank instead of in the boiler. In such cases all the carbonates originally in the water, and that which is formed from the added lime, will be deposited by gravity, if the treating solution be of the proper strength, and neither the carbonates nor the treating lime will enter the boiler.

With sulphates, however, the conditions are different. These require soda ash or soda carbonate for their reduction, the reaction producing carbonates and soda sulphate. The carbonates will be deposited, as explained before, but the soda sulphate remains in the solution, enters the boiler, and constitutes a foaming grievance. It does not form scale, but by concentration makes the water so light that it primes and passes over into the cylinders, and at times even prevents blowing the whistle.

Thus we pass from one trouble to another; in fact, one large western road is following the practice of leaving waters untreated if they would contain 50 grains per gallon of foaming matter after such treatment.

A water may contain 30 grains incrusting and a like quantity of foaming matter to the gallon; the treating of such water (if the incrustants be sulphates) would result in over 60 grains of foaming material, and the road referred to advises that the foaming water seems to search the joints of the boiler much more actively than good water—in other words, causes leaks.

Baryta hydrate has been suggested as a means of preventing foaming, by forming baryta sulphate, which is insoluble and will precipitate, but its expense is prohibitive. Ordinary treatment of lime and soda ash can be made for from two to six cents per thousand gallons for chemicals. It seems as if the only way in which foaming can be obliterated is by distillation. The cost of this method has generally been considered beyond reason, but by means of an apparatus devised by our fellow-member, Professor Goss, distilled water may be produced for thirteen cents a thousand gallons, figuring coal at one dollar per ton. In localities where it is necessary to haul water any distance, say fifty miles or more, the still may show a very nice saving, and the cost of the apparatus

will not, perhaps, exceed that of the equipment tied up in water service. A model of such an apparatus has been tried on water containing 400 grains per gallon, and has demonstrated its practicability.

It would be well to have each particular water thoroughly studied and find out whether, after treatment, it will be all that is desired, or we may spend considerable money and still be disappointed in our results. These suggestions are not intended in any way as a reflection upon the treatment of waters, as we believe that railroads must come to recognize it as good practice, but it is intended as a caution to those who expect a speedy relief from all boiler troubles, without taking the necessary steps to prevent simply a correlation of trouble.

THE PRESIDENT: You have all heard Mr. Henderson's paper; it covers a subject I think we are all very much interested in. It is now open for discussion. Mr. Davidson, cannot you tell us something on this subject?

MR. G. M. DAVIDSON (C. & N. W. R. R.): Mr. President, I prefer to have somebody else start the ball rolling; however, as no one seems inclined to do so I will offer a few criticisms on Mr. Henderson's paper.

He states "The different waters were doctored with lime or soda ash, or both, as analysis of the water indicated necessary," and that the cause of foaming was on account of this doctoring. Now, there are several causes of boilers foaming. First, there may be an excess of soda ash. There are two kinds of soda ash on the market, known as the "dense" and the "ordinary." Chemically they are the same; physically they are not, the dense being compact and the ordinary being light and fluffy. When we used soda ash in tenders of locomotives it was customary, as a matter of convenience, to measure it instead of weighing it—put in so many pailfuls of it. Sometimes we would get one kind and sometimes another, the consequence being we did not get regular results. In putting in soda ash it is easy to overdo or underdo, on account of there being two kinds and nothing in their appearance to distinguish them especially. I have had a practical illustration of the foaming tendency of soda ash. We had at DeKalb, Ill., a certain water which contained about four grains of soda ash per gallon. Engines leaving Clinton would do very well until they got to DeKalb, where they filled their tanks with this water containing soda ash; and after leaving DeKalb they commenced to foam. I talked with a great many engineers about this, and, while they did not know just what the trouble was, they thought it was the water that caused it. I invesigated this and found that the water contained soda ash in solution. Whenever they left DeKalb the water foamed, while it did not foam before they got there.

In regard to the amount of soluble salts that can be used in water and still have the water usable, I might say that we have some waters in Minnesota and Dakota that are loaded down with soluble salts. I

had occasion recently to look over the analyses of some of the waters on the Dakota division, and I had no trouble at all in finding ten in which the soluble salts ran from 86 grains to 121 grains per gallon. We are using this water every day; not because we think it is first-class water, but because we have nothing else up there. But it goes to show that we can run locomotives and are running them with water that contains from 86 grains to 121 grains per gallon of soluble salts, most of it sulphate of soda. We have one water that has 102 grains of sulphate of soda in it, and we have another one that has 89 grains of sulphate of soda in it. The reputation among the operating men and the engineers is that the one that has 89 grains of sulphate of soda causes more foaming than the one with 102 grains; naturally the question came up, why? A study of the analyses showed that the one that has 89 grains in it has, in addition, 12 grains of soda ash per gallon. There we have another indication that soda ash is the cause of a great deal of foaming. Soda ash, in my opinion, is the worst chemical to cause foaming that we have to contend with—a great deal more so than sulphate of soda or chloride of soda. This water with 102 grains of sulphate of soda in it did not foam as much as the one with 89 grains of sulphate of soda, because the one with 89 grains had, in addition, 12 grains of soda ash. There being an excess of soda ash, the water, of course, could not contain sulphate of lime.

Another cause of foaming is dirty boilers. We found when we first commenced to use softened water that we had a great deal of trouble the first week; and when we came to wash out the boilers we were surprised at the enormous quantity of old scale and dirt that came out. After they were washed out and started again we did not have any trouble until some more old scale was detached. After the scale was all out our troubles ceased.

Another reason for foaming is that the water in the boilers is not changed often enough. We must not think because we are using treated water that we must never change the water in the boiler. It ought to be good practice once a week to let that water run out and fill the boiler with fresh water.

The principal cause of foaming, in my opinion, is the presence of fine precipitates in suspension. Carbonate of lime is the usual one. With the intermittent process the only chance to get carbonate of lime in a treated water is when the suction pipe from the settling tank leaks. We have simply a piece of galvanized iron pipe attached to a float, so that we draw the clearest water from the surface. We have had one or two cases where this pipe leaked; one case where it became unsoldered, so that we were drawing in with the clear surface water a whole lot of water from the bottom of the tank which was loaded down with a fine precipitate of carbonate of lime. That water caused foaming, and we investigated and found that the pipe was broken; when we put in a new pipe the trouble stopped right away, so that we had no more foaming.

With the continuous process you are apt to get carbonate of lime into your water when you pass the water though the apparauts too rapidly. It is a well-known fact that the reaction between soda ash and sulphate of lime is very sluggish, especially in cold water. If you attempt to pass a volume of water through a softening apparatus so that it is not in the apparatus more than three or four hours, if the water contained such sulphate of lime you are very apt to have it go through the machine and still contain sulphate of lime; the reaction is incomplete, and it will allow the precipitate to collect in the railway supply tank and eventually reach the boiler and cause foaming.

One point I want to criticise is what Mr. Henderson says about the Omaha boiler compound. We are supposed to be a technical society, and as such should call things by their proper names. I have not any doubt but that Mr. Henderson knows what the Omaha boiler compound is; and if it is any well-known chemical he ought to tell us what it is. Simply to say "Omaha boiler compound" does not convey to us any information.

Mr. Henderson names figures showing a cost of from 2 to 6 cents per thousand gallons for chemicals. I do not know just how he obtains the figures, but I think the average is less than 2 cents. I have under my supervision sixteen water softening plants in operation; some of them have been in operation over a year, and I may say we keep a careful record of cost, so we know exactly the cost of chemicals, cost of fuel and labor and everything else at each of these sixteen plants. The cost of chemicals per thousand gallons is less than 1 cent at seven of them; at seven others it ran from 1 to 2 cents, and at two of them from 2 cents to 2.7 cents; so when he names 2 to 6 cents as the cost his figures are higher than the average.

Mr. Henderson states that it costs 13 cents per thousand gallons for distillation, figuring coal at one dollar a ton. I do not know where he can buy coal at a dollar a ton, unless it is at the bottom of a coal mine, and we certainly do not want to set up a distilling apparatus there. Most of our alkali waters are located way off from coal regions, so we would have to pay for the transportation of coal to where the water is and in that case, of course, it figures a great deal more than a dollar a ton.

I agree with Mr. Henderson in regard to what he says about each water being particularly studied. I think it is a mistake to go into the water-softening business without knowing exactly what you are doing; therefore I think it is excellent practice to study each water—not only take a single analysis, but take analyses at different seasons of the year and under different conditions, before a rain storm and after a rain storm. I found during the wet weather we had this year that the character of some of our well water has changed. The rainwater, coming through the ground, comes in contact with gypsum, or chalk, dissolves part of it and carries it to the well, so that each particular well water

requires a careful study to make a treatment suited to that particular water.

THE PRESIDENT: Mr. Quayle, we would like to hear from you on the subject.

MR. ROBERT QUAYLE (C. & N. W. Ry.): Mr. Chairman and Gentlemen: I do not believe I want to touch very particularly upon the paper that is before us. Mr. Davidson has touched upon some points, and inasmuch as this is a paper that ought to be discussed by the chemists that are here I will simply confine my remarks to the chemical side of it.

We have 350 miles of road now, that is, continuous miles of road, over which we run about 200 locomotives that are constantly taking water from these plants, and the master mechanic—who is present today—finds that his troubles have been lessened very considerably. As a matter of fact, we know, as railroad men, that some supply men will come to you and say: "Mr. So-and-so, I have something that is most excellent and will improve certain conditions that exist on your road, and I want you to give me the worst old locomotive you have and I will apply it, and will show you that I can make a considerable improvement." Now, the motive power man, who has already a man on the job, will readily say that we can improve the worst conditions ourselves. What we wish to do is to improve the very best conditions we have; if we can make an improvement on our best practice it is all right. I simply state this as an illustration.

On our road we met the worst conditions we had, consistent with the amount of traffic going over that part of the road where those conditions existed. We took our main line from Omaha to the Missouri river and the Mississippi river, where a heavy power was used and a heavy traffic conducted. Mr. Benjamin, who is master mechanic there, knows that he would have to take the flues out of the boilers about every nine months or less, but with expert care and with the expert boiler washers, that Mr. Henderson refers to, we were able to keep the engines out longer: they were washed out about every other trip with 150 pounds pressure: we had plugs in certain locations of the boiler that would give us access to every portion of it, that we might remove the scale expeditionsly and that would leave our boilers almost clean when we were through. We find that we have reduced the number of boiler makers and boiler makers' helpers on that part of the road very considerably, and we find that the engines are going out and coming in without the difficulties that we formerly had to contend with, but I think even now that a year is a little too early for us to commence to say too much in its favor, because some other objections may arise after a while that we cannot foretell or that we do not know of at present. But we are very much gratified with the results we are obtaining, and I think it is one of the best investments the Northwestern road has ever made.

For example, if we were to take twenty locomotives new, and take ten of them and put them up on our Wisconsin, or on our Ashland and Peninsula division, running from Chicago to the northwest, and take ten

of the same engines, built at the same time, by the same company and under the same specifications, and send them off into the Iowa district, or from Chicago west, we would have this result: that at the end of twelve years we would find that the ten engines that went to the north there would be no patches on the fireboxes, there would be no half side sheets, there would be little or no repairs, because the water in the boiler would not give us any trouble at all. We would find that with the other ten engines we would require new side sheets within from one year to fifteen months—very rarely go beyond that, although we had three or four instances where perhaps it has gone as far as twenty months; within another fifteen months we would require new crown and side sheets. The fact is that on these two divisions we are using practically the same kind of coal, going through the same district a goodly portion of the time, the same mine supplying the coal for both, so it was not in the coal. We think the men on the two divisions are about as good on one as on the other, with the same boiler inspector going over the road, instructing the men as to methods of washing boilers and keeping them clean, precisely, or as nearly as possible in the same manner and with the same pressure and with the same kind of pump. All the conditions being as nearly equal as we could have them, we concluded that it must be in the water, and now the experience we have had during the past year simply confirms our belief that we were right, that it was the water, and we are looking forward now to getting better water on that division where we had the most trouble. As Mr. Davidson explained in his paper here at one time, that in our northern districts we have, as geologists tell us, and as we know, great quantities of gypsum and chalk, through which the water percolates; that is taken up in the water and it gets into our boilers, and that causes the trouble with our water, and we believe, after having experimented with the use of soda ash in our tanks for a period of eight years prior to putting in these water purifying systems, that while that is a very excellent way, in the absence of a better kind of a plan and better results, we are satisfied now that the way to treat waters is to treat it before we put it into our locomotive tanks, and not get that solid that is thrown down by the boiling water into the boiler, but get rid of it before you put it in. We are very much delighted with what we are doing; we do not think that we have the only thing that there is in the United States at all, but we are satisfied with that we have.

MR. E. D. BRONNER (Michigan Central R. R.): I do not know that I can add anything to this discussion; we are not having any experience with water purifying plants. The water, on the whole, on our system is very good. We have, of course, used the soda ash, as most of the other gentlemen who have spoken have, but on account of various troubles we have abandoned it altogether; in fact, we do not attempt now to

purify our water at all, except at one point where we have a filtering plant.

MR. M. K. BARNUM (C., R. I. & P. R. R.): I had about a year's experience on the Union Pacific road with the use of a special boiler compound and with which very successful results were obtained in the stationary boilers of the city water works at North Platte.

The water at that point had about 28 grains of solid matter to a thousand gallons, and it was very severe on the tubes and fireboxes, pitting them badly and causing the fire boxes to crack and corrode around the staybolts. Our shop was just across the street from the water works plant, and I had occasion to inspect their boilers while they were washing them, and, much to my surprise, they were absolutely clean. They had used this boiler compound for a number of years, and I found that the flues had been in those boilers for thirteen years. Our flues in the locomotive boilers had to be changed every nine months, and we were getting about 3,000 to 4,000 miles a month out of them.

With this encouragement we took up the use of this boiler compound, which was made by a Cleveland firm, and introduced it into the roadside tanks by means of attachments to the water pumps, so that it would be distributed in each tank in proportion to the impurities of the water to be treated, not putting it in the locomotive tanks. The average amount used was about eight ounces to a thousand gallons and it cost about 6 cents a pound, making the cost per thousand gallons about three cents, and after the plants were once installed there was practically no cost for attention, as the pumpers added the boiler compound, in addition to their other duties and without any extra compensation.

This system was tried on a district between North Platte and Sidney, 123 miles, where the water was rather worse than that east of North Platte, and where the boiler work averaged about double the amount required on the engines running east of North Platte. The result obtained within a very short time, two or three weeks, if I recollect right, was to reduce the boiler work on the engines using the treated water to about one-quarter of that still required on engines running east of North Platte which were not using the treated water.

We were also able, by partially blowing the boilers out at the end of each trip thoroughly, or changing the water, to run boilers thirty days without regular washing out, and it would have been possible to run longer, but we did not consider it advisable.

This practice we kept up for a year, and the results were quite a saving in boiler work, a saving in the time of the engine, due to not having to be held for boiler washing so frequently, and an increased mileage from the flues, but at the end of the year the cost of treating the water was found to just about offset the saving, and consequently the test was dropped and it has not been taken up since.

On the same division of the Union Pacific they are now installing purifying plants at all of the principal roadside tanks. In the first place

one plant was tested on the Wyoming division, at Point of Rocks, where the water was very bad (I believe it had about 80 grains of solid matter to the thousand gallons), and this was reduced by treatment to about five grains of solid matter, and the results on the road correspondingly good from locomotives using it. As I have not been with the Union Pacific for the past eight months, I cannot give you the figures or results ten of these treating plants on the Nebraska division, and the conclusion has been that the correct way of treating the water is not through putting a boiler compound in the tender, or even in the roadside tank, but to take the impurities out before the water goes into the boiler.

The Rock Island has made quite a thorough test of soda ash in of the tests since December last, but they have been encouraged to put in locomotive boilers with some benefit, but not enough to be satisfactory, and are now about to install water purifying plants on the Kansas Division at fifteen different stations, where most of the water is taken. These are not yet ready for service, therefore I cannot say as to the results which will be obtained.

We have on that division one point, Whitewater, where we obtained water very heavily charged with common table salt, and we have yet to find a chemist that can handle that water by chemical treatment. We have had some talk with Prof. Goss and have considered the matter of installing a distillation plant there, but the question is not yet settled, but that seems to be the only solution of the problem of improving that quality of water. Possibly some one here now may be in position to give some experience in that line, and we will be glad to get the benefit of it.

MR. J. A. CARNEY (C., B. & Q R. R.): I have not much to say on this subject, except I am very much in favor of treating water outside of the boiler. We have been through the soda ash stage, trying to treat defective waters in the boiler, and have practically given it up.

I am very much interested in what Mr. Henderson had to say on distilling water; I personally believe it is the only way that water containing large quantities of sodium salts can be treated successfully and get results which will be a benefit to the boilers, and if you can give us, Mr. Henderson, the method of treatment, I would be very glad to hear of it.

MR. C. B. AULT (Superior Chemical Works): This subject is very interesting to me from the other end. I am not in the railroad business, but in the supply business, and I cannot agree with Mr. Quayle about a supply man offering to take the best conditions and improving them. Usually they want to improve the worst conditions, as their best conditions are usually satisfactory.

There is one point in this paper that I wish to speak of, regarding the distilling of water at 13 cents per thousand gallons, figuring coal at $1.00 per ton. I would like to ask Mr. Henderson if distilled water would not give them pitting and corrosion. As I understand, from going around calling upon engineers and practical men, who are interested in this subject, trying to better their conditions, it is claimed distilled

water is equally as bad as rain water on the boilers. It will absorb the necessary solid matter from the iron, causing corrosion and pitting.

In regard to treating waters, we have samples of waters that were taken from treating tanks after the precipitates were drawn off, and found them heavily charged with soda ash, and the water foams very badly; there is no doubt but that soda ash, if used in excess, will foam, or used in sufficient quantity to precipitate the solids, will cause foaming.

Of course, I am not an advocate of the purifying system, although we have compounds that will purify waters, precipitate them through those systems. We have treated waters that carry 106 grains of solid matter and given excellent results without any bad effects. We made a test on one railroad where the main trouble was foaming. After a six months' run a master boiler maker was sent to examine the locomotive, and reported that the locomotive looked as though it had just come out of the shop. I know this is a very interesting subject: the railroads are all looking for something to better their conditions, and of course we are trying to supply it. Our mechanical engineer, Mr. J. G. Broman, is a member of this club and I know he has something to say on this subject and I would like to hear from him. He is a thoroughly practical man and has had a great many years of experience and is qualified to speak therefrom.

MR. J. G. BROMAN (Superior Chemical Compound Works): I have been a member of this Western Railway Club for the last twelve or thirteen years, and during that time I have heard a great many discussions in regard to the treating of waters in different ways, and the operation of locomotives. Though I am not a railway man myself, still I am interested in the mechanical topics. I have heard discussions on the burning out of fire boxes, flues and stay-bolts, and all such things, and the treatment of the different waters, but I have never heard any discussion of the difference in construction of locomotive boilers for different waters. I find out West they have the same locomotives that they have in the East; the same in the East as they have out West for the different kinds of water.

Some time ago I had occasion to be out West in what is called the alkali district, to which probably Mr. Henderson has reference in his paper, and I found that the water there was entirely of a different nature from that in the East. I was out West investigating the treatment of waters at the request of a railroad official. He wanted to see if I could treat a water that had been previously treated by some purifying plants which did not seem to be giving the desired results. While I had treated alkali waters in other places, they talked of this particular water as being very bad. I found the water very sensitive to heat, which I discovered in riding on the locomotive over a distance of about 1,200 miles. There are no two crews that do their work alike, and of course that has something to do with it. The engines were run at a very high rate of speed, consequently required a very intense fire, which at times over-balanced the steam pressure and raised the water into the

dome, then into the cylinders and out of the stack. At the end of the trip they washed out one of the locomotive boilers on which I had been riding. I took the opportunity to get the measurements of steam space, heating surface and amount of water in boiler. I found the heating surface to be about 35 square feet. The amount of water was about 2,700 gallons. The flues were set close to the bottom of the boiler, allowing no water space for the circulation of the water back to the fire-box.

With this information on my first trip I procured some of the treated water and some directly from the well; then by the use of a test tube I found both waters very sensitive to heat and unlike our water here. They would not make small steam bubbles and float to the surface, but would make large ones and throw the water out of the tube; by adding some chemicals to the water I found I could balance up the alkali and keep the water from being thrown out of the tube. After that I took some soda ash and lime treated water and precipitated soda ash and some of the alkali by cold precipitation. With this knowledge of the water I made a second trip to try my chemical in actual work. On this trip we had a very successful run, partially due to the excellent firemen keeping a uniform steam pressure, which did not vary from 3 to 5 pounds in 200 miles run above or below the regular boiler pressure. The water in this boiler was carried unusually high, leaving only about 8 inches steam space. I asked the engineer why he carried the water so high, and he answered that he wanted to see what my compound was worth. I asked, "If you should let the steam pressure go down where would your water be?" He answered, "In the stack." I said, "But you do not want it in the stack." This was simply a test by the engineer. On the third trip I was sent on another locomotive, but of the same make, the same train, and running at the same rate of speed. In this case I found the conditions entirely different. The first fireman mentioned would break the coal into the proper size, put it on the fire when it was most needed, while the latter would take the big lumps in his hands and throw them in. When these lumps got heated and cracked open they gave out a tremendous fire, and the first thing we knew the water started to foam and come out through the stack, with the pressure lowered from 185 to 110 pounds.

The next thing we noticed was that half of the flues started to leak, next the fire box, and all on the fireman's side, where the water enters the boiler. That showed that the feed-water, which is heavier, and the boiler running through space, carried it to the rear end, where it found a place of resistance. In this particular case I found the engineer opposed to using any boiler compound in his boiler. At the same time I saw a pail with something in it on top of the tender and asked him what it contained. He said it was Omaha Compound. "Well, if you use Omaha Compound, why don't you want to try mine?" He said No! because he did not know anything about it. "Well then, if you use Omaha Compound what effect does it have on the water?" "Oh," he

answered, "it seems to stop the foaming for a while." I said, "Doesn't it stop it for good?" He answered, "No. If the water foams very badly we put in some more compound." "Well," I said, "I am here for the purpose of trying this compound and the officers have ordered some put in your water-tank, which contains untreated well water." Everything went well the first fifty miles, to the next water station. Then the engineer remarked that the compound was all right so far, but after that he let the pressure go down and the result was as previously mentioned. On an average I find that locomotives have to be fired very heavily and water will foam and spray without any chemicals in it, which to a great extent is due to the equalized heating surface, imperfect circulation and too small water space at the bottom for that kind of water.

Once I had a similar experience with a locomotive that would throw water and foam when heavily fired, and we had what was considered good water. We came to the conclusion that the heating surface was too much equalized and retarded the circulation. We then put in a five-inch pipe in the bottom with two three-inch connections, one to each side of the firebox. Later we took out a number of flues nearest the bottom. The feed-water was introduced at the front end in this flue space, directing the current towards the fire-box. We obtained by actual tests about 25 per cent increase in steam capacity.

While out West I saw a number of fire-boxes and side-sheets that had been furrowed and cracked. The water side was fluted and rough, while the fire-box side was perfectly smooth, showing at times over-heating from lack of proper flow of water. In the water tube boiler we find a perfect circulation and can be operated up to 75 per cent of its rated capacity, which cannot be obtained by return tubular boiler or any other make of boilers I know. Another thing, the setting of flues in zigzag shape instead of having them in straight vertical lines, has also a tendency to retard the circulation of the water, carrying the steam bubbles to the steam space. Treated water is all right, but it does not help the circulation of water in steam boilers. I should now like to hear some remarks from some of the gentlemen present in regard to construction of boilers for proper circulation of water.

MR. PRESIDENT: We have a few minutes left to discuss this subject before we take up the next one. I would like to hear from some one else who has anything to say. If not, we will call upon Mr. Henderson to close the discussion.

MR. HENDERSON: If all the discussion is in I will try to answer the questions that have been brought up. I was very much interested in what Mr. Davidson said, especially as he gives it from the strictly chemical standpoint, which I do not profess to do.

Mr. Davidson spoke of certain water containing 89 grains of sulphate of soda and 12 grains of soda ash, and stated that the water foamed very badly. He did not say how much incrusting salt there was in that water, and I thought there was a possibility—I do not know, not know-

ing very much about the analysis of the water—that there might have been some additional sulphates, and with the soda ash treatment, that would make very heavy foaming water.

Mr. Davidson also spoke about changing the water once a week. That, it seems to me, is not very often. I know of some places where the water is changed every trip; a great many places, in fact. Of course that consumes a great deal of time, and I found that in oil burners on the Santa Fe road, where the arch got very highly heated, it was not wise to wash out, or practically change the water, in less than inside of ten or twelve hours, as the fire arch was so hot that it retained the heat a great length of time, and it was not considered wise to wash it out until the arch had cooled down.

In regard to the Omaha Compound, I must say that there seems to be some misunderstanding after all, because one party, by analysis, claimed that it contained liquid hemlock, while other parties claimed that it did not contain any. They must have had a different sample; I do not know whether they make it twice alike or not. While I am not generally in favor of compounds, and I do not want to be considered as being particularly well disposed to the Omaha boiler compound, yet that seems to do more good in the way of keeping down foaming than anything else we had tried. We have tried oil, tannic acid and paraffine. The Omaha Compound would not last a very long time, but it would quiet the water forty-five to sixty minutes.

In regard to cost, Mr. Davidson objected to my putting the cost of treating water from 2 to 6 cents. I was looking over his paper and found that he stated the cost of treating was from 1 to 10 cents, if I remember rightly, so that I think the treatment at from 2 to 6 cents is a little inside of his.

In regard to the criticism of the price of $1.00 for coal, there are a great many places where you can obtain dollar coal. I know of one road where it can be obtained for 20 cents, and you can get some for 50 cents, 60 cents, 75 cents, $1.14 or $1.35. In the tests we have made the oil was charged at the rate of 25 cents a barrel, and we figured that four barrels equaled a ton of coal.

About changing the flues every nine months, I know one point where they changed the flues every sixty days. The water was fearfully bad, and I believe now, with some treatment, they are able to run them two or three times as long, running about six months, but still we consider nine months quite a good length of service. In regard to the fire-boxes having been patched inside of a year, I know of a number of fire-boxes that had to be renewed inside of a year, and this was with water that was very foamy. It seems as if the wide fire-boxes, with the intense heat action, practically drive the water from the sheet; in other words, some tests have been made that would seem to indicate that there was a film of steam next to the fire-box sheet, from one-fourth to one-half inch thick, where the water did not touch the sheet, and, of course, when the throttle is closed and the circulation is stopped, then the water comes

against the side sheet, and it is easy to explain the corrugation. With these fire-boxes it is not as troublesome at the stay-bolts as between the stay-bolts.

Mr. Barnum spoke of blowing out the engine every thirty days on the Union Pacific. I think that is a very long time, indeed, to run; it would be in our section of the country. What we want to get at is not to have to change the water in the wash-out, because it all takes time; even with the best facilities you cannot wash out a boiler, changing the water, within less than six or seven hours, and in the districts where we burn oil it takes ten to twelve hours, and it is that time that it is very desirable to reduce.

Some questions were asked about the still that was spoken of, instituted by Prof. Goss. The test that was made with the still was in Bagdad, Cal., where the water ran about 400 grains to the gallon, 233 grains of salt and about 175 grains of chloride of calcium, and while the still was merely a model which was made for patent office purposes in order to get a patent, yet it demonstrated the fact that the water could be handled. The question that evolved itself in my mind was whether this material, salt and chloride of calcium, would not form a hard scale, but it was found that this could be blown out and practically clear the machine of the water. Of course, in that treatment there was no attempt made to reduce it, and this water was hauled in the trains fifty-seven miles, and the cost of hauling the water up to the tank on the hill was just 30 cents a thousand gallons; the cost at the plant was nearly 13 cents a thousand gallons, and as the consumption was about 100,000 gallons it saved practically $17 a day by the introduction of the plant. However, since that matter was up the proposition of piping in the water has been considered, and as that would give a chance of supplying two or three other tanks on the way, it will probably be put into effect, although it will cost about $300,000, as against about $40,000 for the still. There was practically a stand-off on the capital expense, so that the $17 a day was practically clear saving. I do not know but what I have given you all the information on the still, but if there is anything else you think of I shall be glad to answer. The still, I might say, is a seven-chamber evaporating type, somewhat similar to the type of the British Iron Company distilling plant on the Red Sea, which I believe has distilled water at the rate of forty to forty-five pounds per pound of coal, but this apparatus has distilled about sixty pounds of water per pound of coal. Prof. Goss has a full description of the plant and working plans.

One member has made the statement that distilled water corrodes the boiler. I think that there would be no fear on that score, as the admission of other waters in the boiler will make such a mixture as not to cause any effective corroding.

The statement was made that there was no difference in the locomotives that are used in the East from those used in the West. I think there is a mistake in that. Locomotives in the West that use these

foaming waters are different; for instance, the water space is very much greater. I know of engines that have four and one-half to five inches water space, and it has come to my knowledge that there are engines that have from four to six inches space, so as to give an additional amount of water at the flue sheets. I think that is unusual, so I beg to differ from the statement that locomotives in bad water countries are not different from those in good water countries.

In regard to carrying the foaming water, I know of cases where the water does not appear at all when they are working. As soon as they close the throttle the water rises to near the top of the water glass.

I think, Mr. President, that I have responded to most of the inquiries, although if I have omitted any I should be glad to have them called to my attention.

THE PRESIDENT: If there is no further question regarding the subject of water purification we will take up the topical discussion on "The Application of Grab Irons, Etc., to Engines and Tenders."

THE SECRETARY: Mr. President, this is a subject that is of interest to the Master Mechanics' Association and came up through that association. To put the matter properly before the club it might be well to state some of the facts leading up to it, as far as the Master Mechanics' Association is concerned. I will first read quotations from the original safety appliance act and also from the recent amendments relating to the subject:

Section 4 Act approved March 2, 1893, reads a follows:

"That from and after the first day of July, 1895, until otherwise ordered "by the Interstate Commerce Commission, it shall be unlawful for any "railroad company to use any car in interstate commerce that is not "provided with secure grab irons or handholds in the ends and sides of "each car, for greater security to men in coupling and uncoupling cars."

By an amendment to the above section, approved March 2, 1903, it is

"held to apply to common carriers by railroads in the Territories "and the District of Columbia, and shall apply in all cases, whether or not "the couplers brought together are of the same kind, make, or type, and "the provisions and requirements hereof and of said Acts relating to "train brakes, automatic couplers, grab irons and the height of draw-"bars shall be held to apply to all trains, locomotives, tenders, cars and "similar vehicles used on any railroad engaged in interstate commerce, "and in the Territories and the District of Columbia, and to all other "locomotives, tenders, cars, and similar vehicles used in connection "therewith, excepting those trains, cars and locomotives exempted by the "provisions of Section 6 of said Act of March 2, 1893, and amended "April 1, 1896."

At the Master Mechanics' Convention in June this amendment was brought to the attention of the members and a committee was appointed to consider the matter, and it reported back to the convention as follows:

"The Committee respectfully recommends that the rear of locomotive tenders be equipped with grab irons to conform to the M. C. B. standard for equipping flat cars.

"The law requires that pilot couplers be made operative without the necessity of trainmen going between the locomotive and car. This makes it necessary to devise some method of operating the pilot couplers from the outside. As there is a great diversity of the arrangement and application of pilot couplers, the committee is unable to recommend a standard method of application, but as we are confronted by the law it is absolutely necessary that some action be taken at once in the premises."

After some discussion of this report a motion that the recommendation of the committee in regard to the application of grab irons to the rear of tenders in the manner specified for platform cars was adopted, and the matter of the front end arrangement was referred to the railroads, with the idea of getting an extension of time, as it was considered very important that there be standards adopted for the grab irons in question so that there shall be less danger to employes.

After the adjournment of the Convention the Atchison, Topeka & Santa Fe Ry. Co. petitioned the Interstate Commerce Commission to be relieved from the necessity of putting on any handholds.

On August 17th I received the following letter from the Secretary of the Interstate Commerce Commission:

"As the matter of extending the time to those railroads who applied, for it was coming up on the fifth of August, I addressed a letter to you to inquire what had been done in regard to any action of the Master Mechanics, relating to the proper location of handholds on the front of road locomotives, understanding from Mr. Groobey that the matter had been discussed at the Saratoga meeting, and that there was an expressed intention on the part of the committee to take up the subject with a view to determining the proper location, which would be made the recommended practice of the Association. I therefore wired you inquiring what had been done, and upon receipt of your reply and consideration of the Atchison, Topeka & Santa Fe Railway Company, which had asked that it be relieved from the necessity of putting on any handholds, the Commission issued an order, a copy of which I enclose. The Commission will grant no application for relief from the applying of handholds to the front ends of road locomotives; but, appreciating the value of the suggestions of the Master Mechanics, it earnestly desires that at the earliest possible date the question will be taken up with the view of recommending a practice which, so far as it is possible, will be adopted and made uniform by the various companies. It is solely with that view that the time has been extended. It has been suggested by the Commission that, so far as the members of the Association may properly do so, the men who have to use these appliances should be consulted. It is not believed that there are any railroads in the United States that desire to avoid placing upon the front of their locomotives anything which will be of practical value in the measure of safety to their employes.

"Of course, we hardly suppose that you will be able to inform us of the views of the mechanical departments of the railroads, scattered as they are all over the country, at a very early date; but we want to know that the matter is well under way."

(Signed.) EDW. A. MOSELEY.

As a result of this petition of the Atchison, Topeka & Santa Fe Railway Company the Interstate Commerce Commission issued the following notice:

At a general session of the Interstate Commerce Commission, held at its office in Washington, D. C., on the 6th day of August, A. D. 1903, in the matter of grab irons on locomotives:

"Upon consideration of the petition of the Atchison, Topeka & Santa Fe Railway Company and the argument of the counsel for Petitioner and representatives of Associations of Railway Employes:

"It is ordered, That the time of the common carriers by railroads in the United States to comply with so much of section 1 of the Act of Congress of March 2, 1902, as requires the application of grab irons to the front end of locomotives and sides of locomotives near the front ends, be and is hereby temporarily extended to the 15th day of October, 1903."

The Executive Committee of the Association, at its meeting on August 10th, named as a committee to take up the whole subject, Messrs. C. H. Quereau, of the New York Central, W. S. Morris, of the Erie, and Jas. Milliken, of the Pennsylvania Railroad Company. As to what course the Committee will adopt in handling it, whether it will immediately recommend a practice which it considers safe, or whether it will await the hearing before the Interstate Commerce Commission, I am not advised, but the committee feels that a full discussion before the various railway clubs will be of considerable value to it, and to this end it has been deemed advisable to discuss it at our first meeting. Some of the points suggested for discussion are:

1. What is the best arrangement of uncoupling device which will prevent the necessity of men going between the cars and locomotives in uncoupling?

It appears to be the consensus of opinion on some of the far Western roads that uncoupling rods on front ends of locomotives are not required, as it would be a difficult matter to make them applicable to the various styles of front end couplers.

2. Is it a safe practice to equip the pilots of locomotives with steps and grab irons? If they are so required, is it not an incentive to employes to ride on the pilots, which practice is considered by motive power men as dangerous and unnecessary? It is suggested that the intent of the Interstate Commerce Law relating to this subject is to provide safeguards for employes when necessarily engaged in uncoupling cars and locomotives. If the practice of riding on pilots is dangerous and unnecessary, is it not contrary to the spirit, although in accordance with the letter of the law?

3. The length of time necessary to equip your locomotives after a suitable device has been recommended."

In this connection I have had a good deal of correspondence with the members of the Master Mechanics' Association which shows that there is a great diversity of opinion as to what the law requires, and without asking permission from the members I will quote from some of the letters to show that on account of the ambiguous manner in which the act is drawn, it is difficult to conform to its requirements:

A member in the extreme South writes:

"In the matter of handholds or grab irons as applied to locomotive tenders, I am somewhat mixed and write to ask just what is required to comply with the law. I have looked over what literature I have and failed to find anything and thought possibly you could tell me where to look for what I want. In looking over cuts of recent locomotives I observe a vertical handhold on the rear corner of most of the tanks, and a step. Does the law require these handholds and steps? In looking over the subject of cars it is plain enough, but it is not clear in the requirements for tenders."

A member in the far West writes:

"I presume you are familiar with the circular and letter issued by Mr. Mosely, Secretary of the Interstate Commerce Commission under date of the 15th inst., relative to the different railroads conferring together, and with the employes, as to the most desirable location for handholds on front ends of locomotives and rear of tenders.

"In this connection do you not think it advisable to suggest to the Executive Committee of the Master Mechanics' Association that they consider meeting in conference with the head representatives of the Conductors' and Trainmens' Brotherhood and together decide on the adoption and location of handholds that they can recommend as standard, so that we may all get them as near alike as possible. Should they consider doing so it should, of course, be done as quickly as possible, that we may get this information at the earliest time practicable, thereby permitting us getting the handholds applied within the prescribed time.

There seems to be some doubt as to whether or not the law requires uncoupling rods on front ends of locomotives. It appears to be the consensus of opinion in this part of the country that they are not required. From inquiry made of our connecting lines, they do not contemplate applying them, and it would be a difficult matter to make them applicable to the different style of front end couplers. For instance, as a matter of safety on our line, we use a disappearing coupler on all our passenger engines. One of our connecting lines uses the Leeds coupler, on both of which the knuckles are an integral part of the coupler and consequently do not open.

"Possibly the Master Mechanics' Association has already made its suggestions covering this. If so, I would appreciate it very much if you would furnish me a blue print thereof."

A member in the Northwest writes:

"If, as I understand it, side grab irons on cars are for the purpose of assisting men in getting on the cars and men are not expected to get on engines and tender from the side, I do not see any need of having side grab irons on engines and tenders, nor do I see how they can be located on the side of engines so as to be of any service. End grabirons, I understand, are to provide a means for men to hold on while operating couplers, and it seems to me that in the case of engines and tenders, if the uncoupling rods extend all the way across and are properly located, they would serve as a perfect substitute for grab irons and that it should not be necessary to apply any grab irons to engines and tenders which have uncoupling rods extending the full width."

Another member in the Northwest advises:

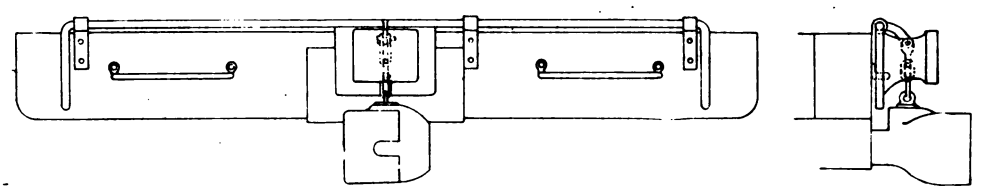
"We have heretofore put steps on the sides of pilots and put ordinary car grab irons above same on top of pilot running lengthwise of the bumper beam. I am not in favor of this arrangement, however, and wish something could be done to interpret the Act of Congress in a different light from the one taken by the Interstate Commerce Commission, as there is no necessity for an employe riding on the pilot of a road engine; he is not called there to perform any duty, and I think it

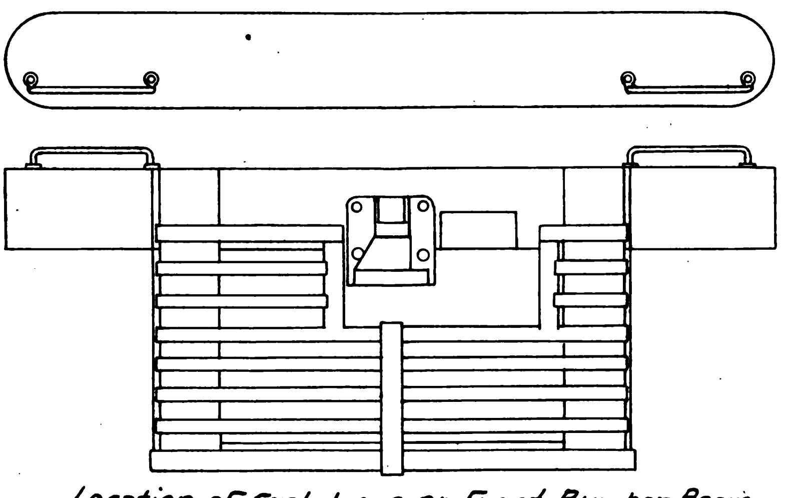
wrong and misleading to place steps and grab irons on the pilot for the purpose of any one holding on, and would like to be able to remove them from all of our engines."

Several of the members of the Western Railway Club, who could not be present at the meeting, have submitted plans showing what they are doing, or propose doing, in order to comply with their understanding of the requirements of the law, and these are submitted as a part of the discussion:

Mr. Lovell of the A., T. & S. F. Ry. writes:

"Referring to your circular letter relative to the meeting of the Western Railway Club to be held on September 15th., also to your favor of September 12th, I am enclosing herewith blueprints (Plate A) showing





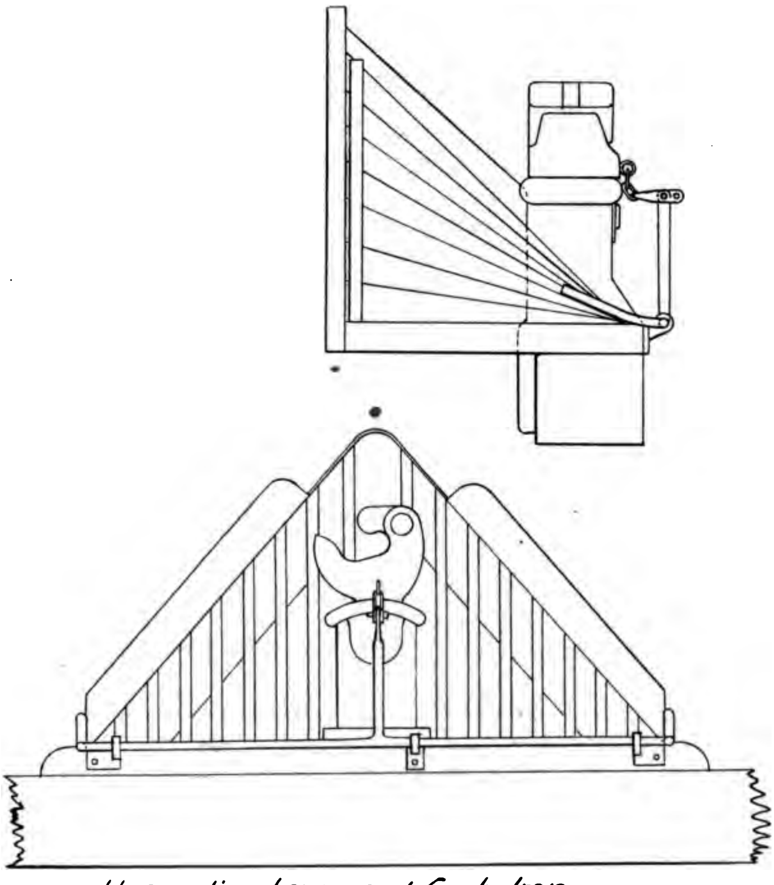
Location of Grab Irons on Front Bumper Beam.

Sante Fe System.

PLATE A

the arrangement of grab irons, etc., to the rear end of our tenders and also grab irons which are proposed to be applied to the front ends of locomotives, fulfilling the requirements of the law. We have already applied the grab irons and uncoupling levers to the rear ends of tenders. The grab irons at the front ends of engines have not yet been supplied, but it is proposed to apply them soon unless some information is received from the committee of the American Railway Master Mechanics' Asso-

ciation, which has this matter in hand, that will induce us to change our views. It is the view of the management of our road that grab irons on the fronts of engines are an element of danger instead of safety, as they have a tendency to induce brakemen and others to walk in front of engines when they would not do so if the grab iron was not there. We do not have steps on the pilots of our road engines, and we object to them on the same grounds as the grab irons, that they would have a tendency to induce employes to go in front of the engines and upon the pilots. The law requires grab irons, and we consider that the arrangement shown by our drawing, enclosed herewith, will fill the requirements of the law."



Uncoupling Lever and Grab Iron.
D. & I. R. R. R. Pilot.

PLATE B

Mr. H. S. Bryan, master mechanic, Duluth & Iron Range Railroad, says:

"I am in receipt of your circular, dated September 3rd, saying that the first Fall meeting of the Western Railway Club will be held Tuesday, September 15th, and that as a 'topical discussion' the question of 'Application of Grab Irons, etc., to Engines and Tenders' will be taken up.

"As I cannot be present at this meeting, I enclose herewith blueprints (Plates B & C) showing Standard Pilot and Tender Couplers, by which you will see that the uncoupling levers are intended for and used

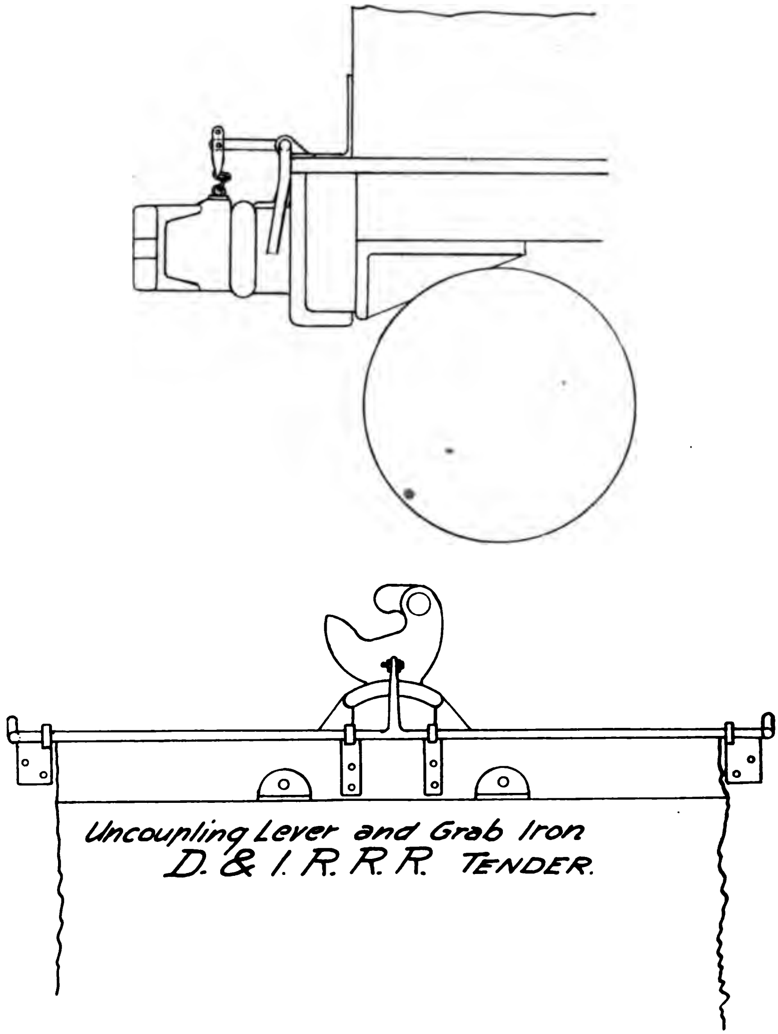


PLATE C

as, grab irons on front of engines and rear of tenders, as well as for uncoupling levers.

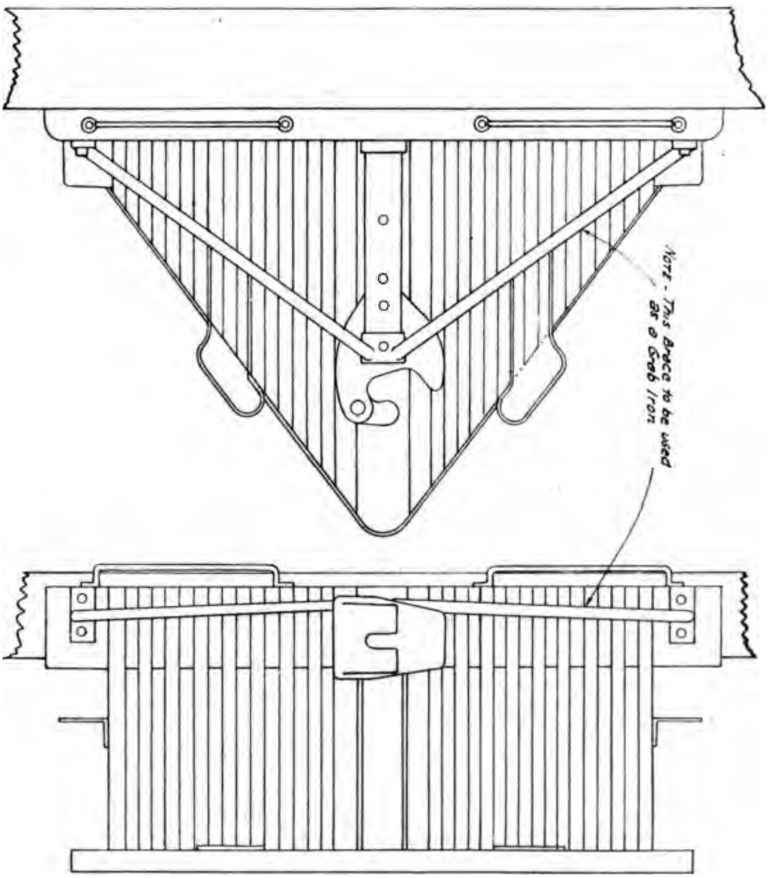
"Since adopting this as a standard, we were assured by one of the

inspectors for the Interstate Commerce Commission that it filled all requirements as a grab iron on front of engines and rear of tenders."

(It will be noted that the device used by Mr. Bryan meets the approval of one of the inspectors of the commission as complying with the law.)

Mr. W. C. Arp, superintendent motive power, Terre Haute & Indianapolis Railroad Company, advises:

"I am enclosing you blueprints, 2570-A, locomotives, arrangements of steps and grab iron on pilot, and 2491-A, location of handholds on tenders. (Plates D & E.) The enclosed prints show the plans we are following

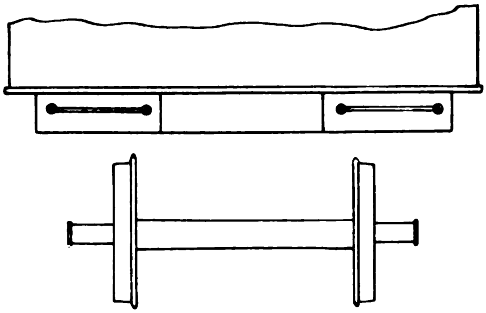


Arrangement of Grab Irons on Pilot
Vandalia Line

PLATE D

in the roundhouses to have all of our engines equipped by October 15, 1903. It is our understanding that this fully complies with the law.

It is not, however, the arrangement we propose to adopt as our standard. We will be governed, so far as it is practicable, by the Pennsylvania lines' standard, and propose, when the matter is definitely settled by the Master Mechanics' committee, to equip our engines with permanent release rigging and handhold for locomotives and tenders. Our present fittings are only temporary."



Location of Hand Holds on Tender

Vandalia Line.

PLATE E

Mr. Garstang, of the Big Four road, writes:

"I have your favor of the 12th inst, advising that the Western Railway Club meeting will be held on September 15th, at which time the question of grab irons applied to locomotives and tenders to comply with the Safety Appliance Act will be discussed. I would like very much to attend this meeting, but on account of previous engagements, will be unable to do so.

"The amendment of March 2, 1903, to the act pertaining to grab irons on locomotives and tenders, is so loosely drawn as to be somewhat ambiguous on the question of the requirements concerning grab irons on locomotives.

"Our General Counsel has written Mr. Moseley, secretary of the Interstate Commerce Commission, asking him if the commission has construed the amendment of March 2, 1903, to the Safety Appliance Act, to require grab iron on locomotives. It occurs to our General Counsel, from a careful reading of this act, that the amendment was for the purpose of extending the original act to the territories and the District of Columbia, and not for the purpose of requiring grab irons on locomotives, to which, up to this writing, he has not received a reply.

"The subject is not understood by any railroad man with whom I have talked. In a letter I received from Secretary Moseley, dated August 15, he states that at some convenient date, prior to October 15, 1903, the matter will come up for further hearing as to the time necessary to enable proper compliance with the statute in this respect, and of that hearing due notice will be given through the public press, or otherwise, as the commission may determine.

"It seems to me that the matter of placing grab irons on locomotives and tenders and the location of same cannot be fully decided until that meeting. I think the action of the Western Railway Club in introducing the subject to be discussed at their next meeting is a good one, and no

doubt will enlighten the commission, as well as the railroad companies as to what had better be done in the premises.

"Personally, I believe it would be a mistake and a dangerous practice to fit up locomotives with steps and grab irons, other than those used continually in switching service. It has always been the policy of the Big Four Company to discourage men from jumping on and off engines when in motion, and an engine equipped with grab irons and steps will be an incentive, we believe, to encourage this practice."

Mr. F. H. Clark, S. M. P., C., B. & Q. R. R., writes:

"Referring to the recent amendment of the Safety Appliance act, extending provisions in reference to safety appliances to include engines and tenders, I am of the opinion that grab irons, steps, etc., on front ends of engines are not desirable. I do not want or expect our men to ride on pilots, and do not think that we ought to encourage them in doing so. Further, I am inclined to think that grab irons and steps should be omitted from the sides of tenders, except at the gangway at the front of the tender, where something of the sort, of course, is required. Our tanks are nearly as wide as clearances will allow, and I believe in the interest of safety that any steps or grab iron applied to tenders should be at the rear end.

"It is quite important that some agreement be reached in regard to this matter.

"We have attempted to apply the recommendations of the M. C. B. Association for the application of grab irons, etc., to freight cars, and we are not very well satisfied with the results."

From the above it will be seen that it is the desire of the master mechanics of the various roads to comply with the law, as soon as the Interstate Commerce Commission decides what is required. It will also be noted, however, that there is an earnest protest against the application of grab irons to the sides of tenders and the front ends of road locomotives because of their being a source of danger to employes rather than a safety appliance.

I would like to say in addition that Mr. Quereau, the chairman of the committee of the Master Mechanics' Association, is very anxious to have as full a discussion as possible from the Western Railway Club, and to get the report of the discussion to him at the earliest possible moment so that he can make use of it in his conference with the Interstate Commerce Commission.

THE PRESIDENT: This subject requires rather speedy action, as I understand the Interstate Commerce Commission expects to have a meeting before October 15th and decide on these questions, providing it can get the committee's report in that time. We should like to hear from members on the subject.

MR. W. G. MENZEL (Wisconsin Central Ry.): I have been at a loss to know just what to do on the grab iron question. Since hearing this discussion by others that are interested in this subject, I have come to the conclusion that the question of equipping tenders with grab irons, that is, merely the tender, is a simple matter. I should take it that if we apply the grab irons the same as they are applied to flat cars, it will comply with the law, and I do not see anything about the uncoupling levers of drawbars but what can be arranged the same as on flat cars, but

it seems to me that with the front end of the locomotive it is altogether a different proposition, and it is really one that should be decided by the legal department of the roads, they to say what should be done, because, when we put a grab iron on the front end of locomotives, we encourage men to jump on the front end and put themselves in danger, and it seems to me it would be a point for the legal department of the roads to take up.

MR. QUAYLE: I think it is rather late for the motive power department of the Northwestern Railway to merely discuss this matter. We have about, or nearly, 1500 of our locomotives now equipped with grab irons. The law required that we should have it done by the first of

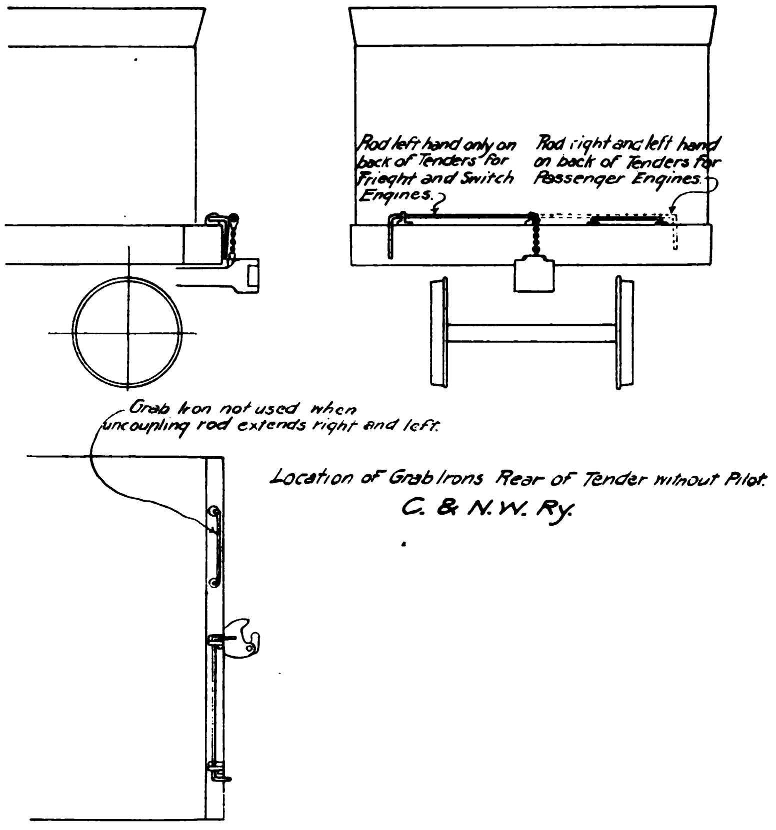


PLATE F

September, 1903, and it is hardly the time now to open the question whether we will do it or whether we will not do it.

I find, too, that the counsels of the different railways, or some

of them, are at variance as to how it shall be done. Some of the railways seem to think that we ought to have steps at the rear end of the tanks, and other railways seem to think we ought to have step ladders on the rear of the tenders. We find that on our switch engines, particularly where they are equipped with the ordinary rod for uncoupling purposes, that the switchmen take it and throw it around the yard; the next time the engine comes to the shop one is put on, but it is not long till it is gone again.

It seems to me the Interstate Commerce Commission ought to consult the switchmen, or the leaders of the switchmen's organization about

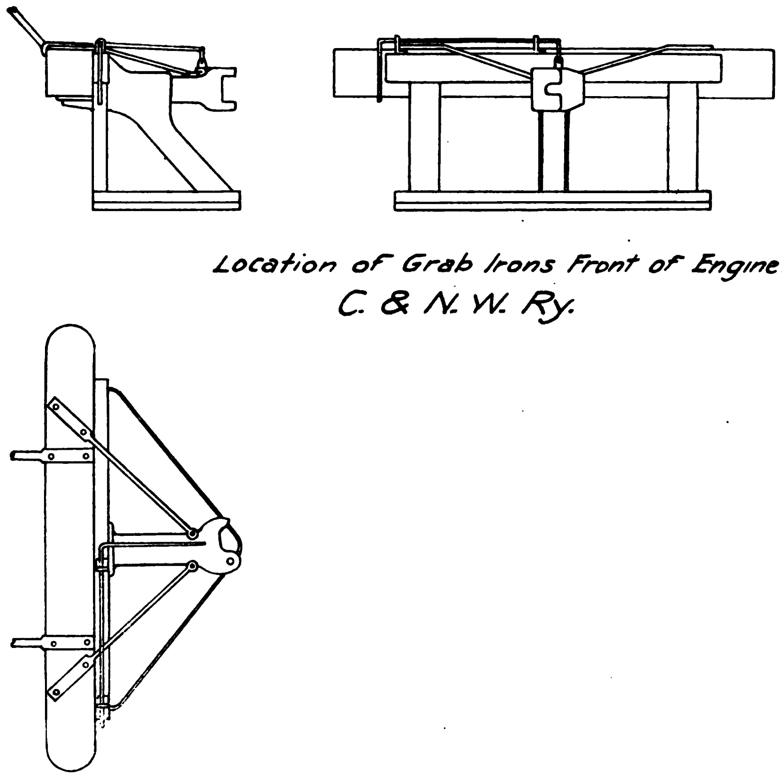


PLATE G

this matter. They claim that when we bend the uncoupling rod 8 inches below the sill that it is in the way and should not be there. I have here some blueprints (Plates F, G & H) which show the device on the Northwestern locomotive; it may be of interest and may not. However, a speaker at this convention has said that we ought not to have grab irons on the front end of the pilot. We have a short stub pilot on our locomotive, the automatic coupler attached to it, and then we

have two angle braces, one on each side, and that runs almost parallel with the base of the pilot and the foot board of the pilot projects out about 5½ inches from the outside of the slats, which gives a place for the man to rest his foot, and this brace running parallel to the base of the pilot gives him an opportunity, always, to hold on to that, if he is jumping on, or if he is riding, to secure himself, and it being equally distant from the base of the pilot, in reaching out his hands to

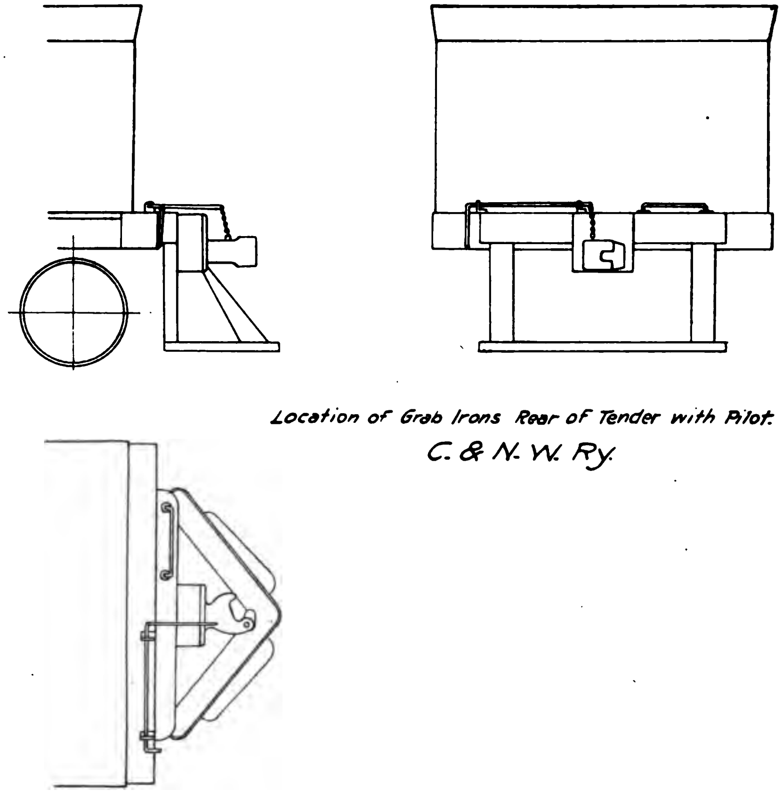


PLATE H

take hold, he always has the same length to reach on any part of the pilot, so that in that way it is somewhat of an advantage, but we have no grab iron other than that on the pilot, and we think it is not necessary to have others.

We try to discourage our men, as far as practicable, from riding on the pilots, and I think that we have a rule on the road that train-men and switchmen shall not ride there, as we think it not a good place for them to ride; we do not wish to encourage it at all.

This blueprint also shows the grab irons on the back end of the

tender. The uncoupling rod on the back end of the tender extends to the right and left side on the rear end of the tender, and that acts as grab iron for the man who wishes to use it. We have no step, however, on the back end of the road tenders, but on the front end of the switch engines we have a rod, or pipe, rather, that runs clear across, and the same is true of the back end.

I do not know that I can say very much more about this. The blueprints will show for themselves just what we are using, and I would like to have this introduced in the paper, if you think it would be well to do so. If there are to be any changes from that, we will have to change practically all of our locomotives. The first notice I had was a letter from Mr. Mosely, of the Interstate Commerce Commission, calling my attention to the fact that I was one of the committee, and that he would like to hear from me on the subject. I took the matter up with Mr. Quereau, and Mr. Quereau tells me he has practically done nothing about it as yet, and he has only become interested in the matter within the last few days; the letter was dated September 5th. I presume the commission will probably extend the time sufficiently to allow us to give the matter considerable thought, and that the motive power departments of the railways may be enabled to adopt a standard, or as nearly so as they can.

We are not in favor, on the Northwestern railway, of having grab irons on the sides of engines, nor on the sides of our tenders; we think they are very bad things to have. They get them out beyond sometimes, where men are not looking for those projections, outside of certain fixed points on the tenders, and if they are, they are likely to get hurt, and we think such constructions are rather more dangerous than they are helps in the way of safety.

MR. J. A. CARNEY: The practice on the C., B. & Q. for a number of years in reference to the end of tenders has been to have two grab irons; one on each side of the coupler, and the customary pin lifter. The Master Mechanics' instructions to equip tenders the same as a flat car is equipped, is very easily done, but it can be done in such a way as to render the safety appliances absolutely dangerous, although complying with the law. We have received instructions how it should be done, and in looking at one of our newest tanks equipped according to instructions, I found that the outside sill was some ten inches inside of the edge of the tank body, and if we were to put on a foot hold on the sill, as the drawing indicated, it would be almost impossible for a man getting on the tank to reach the foothold. The instructions, so far as I am able to see, that have been furnished by the Interstate Commerce Commission, simply say we want safety appliance, but they do not say how safe they should be.

It is my opinion that the grab irons on the front end of the locomotive, or on the side of the tank or where they will allow the trainmen or enginemen to get on to a road engine at any place other than the

gang way at the cab are dangerous. We have equipped one or two engines at odd times that have been used in way-freight and switching work, with side steps, and we found them very convenient on branch lines, but we always felt that they were not perfectly safe.

It is my opinion that the less places there are to get on an engine or a tank outside of the gang way between the cab and tender, where a man is supposed to get aboard, the better we are off.

MR. P. H. PECK (C. & W. I. R. R.): I am not bothered with any engine pilots. I have, on the switch engines that we use, steps and hand rails on both ends of the engine, but none on the side, for the reason, as Mr. Quayle states, some of the clearances are very close, some telegraph poles and interlocking signals are very close, so that a man riding there and not paying any particular attention, might get knocked off, and we have always considered side steps dangerous. We have even taken off the tender steps and made them higher, so that a man could not ride low down. Where locomotives are equipped with pilots, I do not see why it is necessary for a man to get on between the pilot and car on any occasion, where you have your unlocking devices come out to the end of the pilot beam. With the old-fashioned drawbars, when we had these old push beams, they had to get on, but now there is no occasion, and that is verified by the fact that the drawbar and knuckle is cast in one piece; it shows a man has no reason to go in between there.

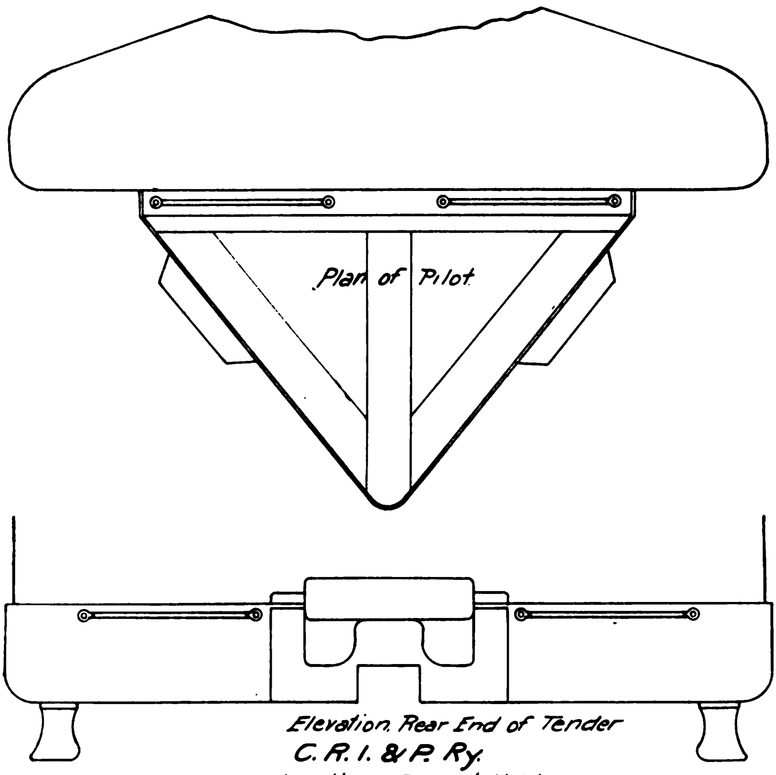
MR. BARNUM (C., R. I. & P. Ry): This matter has come to the attention of the mechanical department of the Rock Island road, the same as other roads, and our mechanical engineer, Mr. Seley, and I have checked the engines up very carefully, both on our blue prints and in the roundhouses, and after looking them over thoroughly, we have come to the conclusion that there is no real necessity for grab irons on either the front or the back of the engines, or for an uncoupling rod for the pilot coupler, although we have made blueprints (Plate I) showing how they can be best applied to our engines, and will submit them to the secretary for his records. (See opposite page.)

We have come to the conclusion that these devices will add nothing whatever to the safety of enginemen or trainmen in service, and if we are eventually required to apply them, it will simply be to comply with the law, and not because we think them actually necessary as a means of increasing the safety of our employes.

MR. MENZEL: I would like to ask a question. What if our drawbars on our locomotives are made solid; If this were done I do not understand that we would comply with the law. My understanding is that the couplers on locomotives must be automatic, the same as on cars. It sometimes becomes necessary to couple two engines together, and this could not be done if couplers were solid. I do not think that we can get around that point, that we must have automatic couplers with uncoupling levers, but I do not think it is going to be in the

interest of safety to put grab irons and coupling levers on the front of locomotives.

A MEMBER: I would like to say on that subject, that I do not think there is any difference of opinion about the necessity for an uncoupling rod at the rear of the tender, so that engines coupled one to the rear of the other would have an uncoupling rod on the one engine; it is im-



Elevation Rear End of Tender
C. R. I. & P. Ry.
Location of Hand Holds

PLATE I

possible to couple two road engines together where they are fronting each other.

MR. BARNUM: Our road engines are equipped with uncoupling rods, both on the back of the tender and on the front end of the engine. These uncoupling rods are arranged so that they can serve as a grab iron, as they do on a freight car. We do not put any grab irons on the sides of our tenders, nor steps on the sides of our engines, outside of the regular steps and grab irons that are between the engine and the tender. When you look for the reasons for the law compelling the use of grab irons and steps on the sides of freight cars, you can see very well why they are necessary; the trainmen have to get on the top of those

trains at all times and at all places, and they serve a useful purpose, but on an engine that is already equipped with steps and hand holds to get in the gangway, I cannot see any necessity for any other grab iron or steps on the sides.

THE SECRETARY: The Illinois Central Road has submitted a drawing showing their method of applying grab irons and pin lifters to the rear of tenders. It will be shown in the proceedings. (Plate J.)

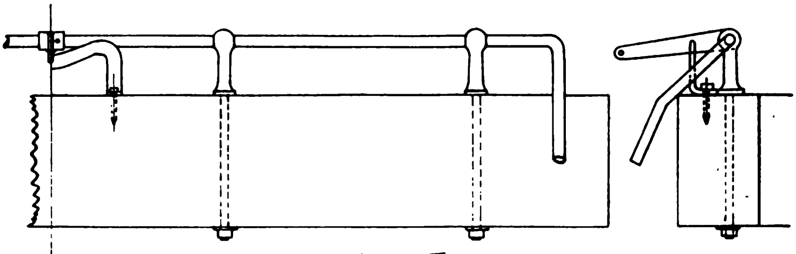


PLATE J

MR. C. A. SELEY (C., R. I. & P. R. R.): I do not know whether it is wise or not, but I am going to make a suggestion, and as a test of the sense of this meeting, I would move that a resolution be framed and voted upon by this club, to be sent to the committee, expressing the sentiments of this club essentially in the form as stated by Mr. Barnum, that this club does not believe that it is advisable or necessary to equip the front ends of locomotives with grab irons as safety appliances. We have no objection to the equipment of the back end, if it is in conformity with the action of the Master Mechanics' Association, but so far as the front end is concerned, we believe that grab irons are not advisable or necessary as safety appliances. I will make that as a motion, that such a resolution be framed.

Seconded by Mr. Menzel.

MR. QUAYLE: I think Mr. Seley will accept the additional words, "and on the sides of tanks."

THE SECRETARY: The motion and amendment, as stated by Mr. Seley and Mr. Quayle, is that this club does not believe it is advisable or necessary to equip the front ends of locomotives, or sides of tanks with grab irons as safety appliances.

MR. SELEY: That of course takes into consideration the fact that the front ends of our engines are now equipped with signal holders and in many cases, as Mr. Quayle says, with braces to couplers and other arrangements that a man may lay hold upon in getting upon the front end of the engine if it is necessary. We wish to discourage that as much as possible, and believe that all the needful attachments for a man to use are there provided, but these additional hand-holds or grab irons are inadvisable.

THE PRESIDENT: Is there any further discussion on this motion?

MR. PECK: I think it would make that resolution more clear if it would state, "locomotive equipped with pilots." A great many engines are not equipped with pilots.

MR. SELEY: I think that the words "road engine" will cover that.

Motion was then put to vote and carried.

It was moved by Mr. Quayle that the discussion be closed and that the meeting adjourn.

MR. SELEY: I did not, in putting my motion, mean to have the matter closed before proper provision was made for the framing of the resolution, and I merely put my motion as a test of the sense of the meeting. Of course it is for you to decide whether the motion shall be framed by the secretary, or sent in the form that it is at present.

THE PRESIDENT: The secretary will take care of the resolution. The motion is that the discussion be closed and that we adjourn.

Adjourned.

The David L. Barnes Library

Special Notice.

The David L. Barnes Library of this Club, at 1750 the Monadnock, Chicago, is open for the use of members and their friends, and we hope it will be used freely. It is open on week days from 9 a. m. to 5.30 p. m., except on Saturday, until 3 p. m. Books must not be removed from Library, but the Librarian will assist visitors in finding information and will promptly reply to letters from out-of-town members desiring information from the Library. Donations of books and technical publications will be gratefully received.

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897
Library, 1750 Monadnock Bldg.

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The regular monthly meeting of the Western Railway Club was held on Tuesday, October 20, 1903, at the Auditorium Hotel at 2:30 P. M. Mr. M. K. Barnum in the chair.

Among those present the following registered:

Armit, J. L.
Ault, C. B.
Barnum, M. K.
Bement, A.
Bourne, G. L.
Bower, J. C.
Brooke, Geo. D.
Brooks, P. R.
Brown, J. Alex.
Bryant, Geo. H.
Bryant, W. F.
Butler, L. E.
Conger, C. B.
Cushing, Geo. W.
DeRemer, W. L.
Deverell, H. F.
Doebler, C. H.
Downer, E. N.
Ducas, C.
Dunham, W. E.
Farmer, G. W.
Fenn, Frank D.
Fitzmorris, Jas.
Forsyth, A.
Forsyth, Wm.
Gardner, J. W.
Goss, W. F. M.
Haig, M. H.
Hill, J. W.
Hinson, J. A.
Hogue, O. D.
Hoover, A. E.
Hubbell, Ira C.
Keeler, Sanford.
Kilpatrick, J. B.
Kirby, T. B.
Kuhlman, H. V.
Linn, H. R.
Long, J. H.
Lovell, C. P.
McAlpine, A. R.
Midgley, S. W.
Mileham, C. H.
Mills, Geo. F.
O'Neal, Thos.
Otis, Spencer.
Patterson, J. B.
Peck, P. H.
Perry, A. B.
Pflager, H. M.
Priseler, H. W.
Royal, Geo.
Setchel, J. H.
Sherman, L. B.
Shultz, F. K.
Stocks, W. H.
Sullivan, S. F.
Taylor, Jos. W.
Terrell, C. D.
Throop, W. B.
Thurnauer, Gustav.
Van Alstyne, D.
Vissering, H.
Waggoner, W. B.
Wickhorst, M. H.
Wilson., G. L.
Winslow, H. L.
Woods, E. S.

The meeting was called to order by the Secretary.

THE SECRETARY: Mr. Crawford, the President of the Club, is out with the officers of his road on annual inspection and cannot be with us today. Mr. Parish and Mr. Carney, the Vice Presidents, are both out of town, so I have asked Mr. Barnum, Supt. M. P., Rock Island road, who is a member of the Board of Directors, to preside over the meeting today.

THE CHAIRMAN: Gentlemen, the Secretary has called the meeting to order. The first business to be transacted will be the approval of the minutes of the last meeting. These have been published, and if there are no objections, they will stand approved as printed. The Secretary has some announcements to make, I believe, in regard to membership.

THE SECRETARY:

Membership, September, 1903		1,057
Resigned	2	
Dropped, Mail Returned	10	12
Total		1,045
New Members	13	
Reinstated	2	15
Total Membership		1,060

NEW MEMBERS.

NAME.	OCCUPATION AND ADDRESS.	PROPOSED BY
Geo. Goodrich	R. F. E., C., B. & Q., Creston, Iowa	A. S. Wilson.
W. R. Toppan	Manager Railroad Department, Kennicott Water Softener Co., Chicago, Ill	Jos. W. Taylor
G. L. Dillman	C. E. Western Pacific Railway, San Francisco, Cal	J. W. Taylor.
J. G. Crawford	Special Apprentice, C., B. & Q. R. R., Aurora, Ill.	J. A. Carney.
W. H. Williams	Asst. to General Manager, B. & O. R. R., Baltimore, Md	F. W. Busse.
F. W. Herbert	Draughtsman, L. E. & W. R. R. Co., Lima, Ohio	W. White.
W. H. Coats	Loco. Engineer, Ill. Cent., Chicago, Ill	R. N. Coats.
B. F. Haller	Iowa Central Railway, Iowa Falls, Ia	R. N. Coats.
A. L. Guilford	Manager Ajax Manufacturing Co., Chicago Ill	C. H. Doebler.
Thos. Plunkett	Revere Rubber Co., and Detroit White Lead Works, Chicago, Ill	S. Keeler.
J. B. Kilpatrick	Asst. of M. P., C., R. I. & P. RY., Chicago Ill.	M. K. Barnum.
Thos. O'Neal	Gen. Boiler Insp., C., R. I. & P. Ry, Chicago, Ill.	M. K. Barnum
T. H. McGoff	M. M. A., T. & S. F. Ry, Ft. Madison, Ia.	A. L. Beardsley.

THE CHAIRMAN: If there is no other new business to come before the meeting, the next on the program will be the reading of the article on

"Leaky Fireboxes," by Mr. T. S. Reilly, Associate Editor, Railway and Engineering Review.

MR. REILLY: In order to get through with this as quickly as possible, I will read what few remarks I have to open with. In the first place I want to say ,I have no idea of attempting to point out how to build a boiler which will not leak. Neither are such examples as are used in the paper held up for criticism. The particular examples were selected from a great number available, solely because their sizes and relations to their engines made them most readily comparable—all being typical examples of their several classes. I have taken a look back over past practice and have made a comparison of it with that of the present, and the conclusions upon the results of which are embodied in the paper before you. The work of this review and comparison was lessened through use of the formulas and recommendations prepared by Mr. G. R. Henderson, which are embodied in the 1897 M. M.'s proceedings, and as a criticism already made upon the present paper indicates an impression that these formulas have been outgrown, it may be well to consider them a moment. These formulas, with their constants are based upon the work performed, and their correctness in covering the practice in use at the time of their presentation cannot be and never has been questioned. As their application is based on cylinder volume, however, it has been advanced that they are in need of modification. This may be done by modifying the constants, but personally I do not think even this is necessary, for we have merely increased the steam pressure instead of the cylinder volume, in practically an exact proportion. For instance, take a locomotive with 21 x 28 cylinders, whose boiler carries the 140 pounds of steam of the old practice. The formulas quoted would call for a boiler for such an engine, whose total heating surface would be 2,180 square feet,. and a grate area of 36.1 sq. ft. In increasing the size of this locomotive, say 42 per cent., by modern practice, we raise the steam pressure to 200 lbs., or an increase of about 42 per cent over 140 lbs. Increasing the heating surface and grate area obtained by the formulas just mentioned, by 42 per cent. we will have the 3,096 sq. ft. total H. S. and 51.4 sq. ft. grate area, which is typical of a modern example. In the old way we would have retained the 140 lbs. steam pressure and merely increased the cylinders 42 per cent., which would give us 25 x 28 ins. cylinders. Applying the formulas to these cylinders, we will find that they call for the same size of boilers and grate area to supply the 25 x 28 cylinders at 140 lbs., as we use at present with 21 x 28 cylinders at 200 lbs. steam pressure. The 42 per cent. less diameter of cylinder used with the modern boiler will require 42 per cent. less volume of steam, but in raising the pressure of the steam 42 per cent. higher in order to use the smaller cylinder, we must put a greater quantity of heat into the water which makes the steam, and while the greater amount of heat may not amount to 42 per cent., yet the performance of the modern boiler indicates the amount is not enough less as to vitiate the appli-

cation of the formulas to present practice by observing the percentage of increase in steam pressure. This is my reason for believing I am correct in basing the comparisons upon the '97 formulas.

What personal locomotive experience I have had has been mostly in bad-water districts, where all boiler weaknesses are so aggravated as to become quickly apparent. So far as my observation has extended I can hardly believe that the excessive "tenderness," if one may so express it, of the modern boiler, is due solely to the high steam pressure, for narrow-box boilers carrying the same steam pressures appear on the whole to be less susceptible to the abuse and poor workmanship we hear so much about—although neither of these types of modern boilers will stand this abuse to the extent the older types do. Yet the form of the narrow-box boiler would seem to offer a circulation more defective than in the wide box, and the higher rate of combustion demanded of the narrow grate would seem to direct a more intense amount of heat upon the tube sheet, through the stronger draught required. If, then, an apparently much more distorted shape of boiler gives less trouble than the apparently better shaped wide-box boiler, despite the same steam pressure, and the same amount of abuse from the roadmen and shopmen, wherein does the difference exist which is the cause of the trouble with them? The present paper points out the only appreciable difference observable, other than that of steam pressure (which in many cases is the same) and this difference is one which has of recent years been considered unimportant, I have thought that, in view of the present interest in the general subject, it might be well to draw attention to the point, so that by regarding the matter from a new point of view it may be considered whether it would not be well to return somewhat to a proportion of firebox heating surface which the older designers chanced upon with seemingly excellent results, in addition to our present efforts to afford a better water circulation and which is at present giving better results abroad than we are getting from our boilers in this country.

CONCERNING LEAKY FIREBOXES.

By T. S. Reilly, Associate Editor, Railway and Engineering Review.

The report of the committee on "Recent Improvements in Boiler Design," to the 1903 convention of the Master Mechanics' Association stated that: "boiler troubles have increased in proportion to the increase in size and steam pressure of boilers. The roads having very little trouble with old boilers are having very little more trouble with modern boilers, and those which have always had a good deal by comparison, are having a good deal more with their modern boilers."

If we take this admission that the older boiler gives less trouble, than a comparison with the newer one may develop other reasons for this increase in trouble than that due alone to the increase in steam pressure and size. Undoubtedly the increase in pressures has a tendency to aggravate boiler troubles, but that the mere increase in size should have such effect appears hardly reasonable, particularly as this increase in size is generally made through the adoption of the wide firebox, which would seem to produce a form of boiler that should give much less trouble in every way than the narrow box. The reverse, however, seems to be true in service of existing examples. In the discussion of the report cited a great variety of conjectures were advanced as to the reason for this greater trouble with wide boxes. The consensus of opinion favored the view that faulty circulation, due in a great measure to excessive crowding of the tubes, was the principal cause, and a wider spacing of the tubes was advocated.

While any improvement in circulation will, of course, benefit any boiler, yet the comparison we have undertaken, may, by exhibiting the cause for the required increase, enable us to reduce the occasion for it. The boiler which one calls to mind as giving the least trouble from leaking and most reliable in all respects, is the old deep firebox boiler, on an engine whose cylinder demands had not outgrown the relations set forth in the 1897 recommendations. For ordinary bituminous coal these were:

Total heating surface = 205 Vt., where Vt. = volume of both cylinders in cu. ft.

Grate area = 3.4 Vt.

Tube length = 70 to 90 diameters.

H. S. in firebox = 10 % of total H. S.

A typical modern boiler represents 30 to 60 per cent flat increase on these sizes,* with the exception of that portion of the total heating surface placed in the firebox, which has fallen to 5 per cent on an average and

*With respect to cylinder volume. Really, however, there is very little increase, as we increased steam pressures rather than cylinder size.

even less in some cases. Our troubles are practically all confined to the firebox—the call for increase of circulation is from the firebox, yet the shallow leg in the modern boiler would seem to afford freer circulation.

Is it not logical to presume then, that, aside from the increase in steam pressure, our principal trouble arises from the reduction in the per cent of total heating surface placed in the firebox, which has accompanied the widening of the grate. For it is obvious that what one might term the "evaporative duty" of a square foot of firebox heating surface will, with any fixed amount of grate area, be much greater in a box containing 150 sq. ft. than in one containing 200 sq. ft. And a freer circulation will be necessary in order to enable this higher evaporative duty to be performed. If this freer circulation is not furnished the sheets will become overheated and the observed leaking and cracking is the result. Equally obvious is it then, that the most practical remedy would seem to lie in increasing the amount of heating surface in the firebox to a percentage which would not demand so high an evaporative duty of the sheets, and an inspection of a wide range of examples would indicate that such a course would be merely a return to the proportions of firebox to total heating surface in general use a few years ago.

There seems to be a general impression that in the wide firebox we are using a larger grate in proportion to the boiler than in the past and that hence we are not requiring so high a rate of combustion per sq. ft. of grate area. Let us see!

Take a 21x28 engine. Vt. $= 11.225$.

Total H. S. $= 205 \times 11.225 = 2301$ sq. ft.

Grate Area $= 3.4 \times 11.225 = 38.2$ sq. ft.

A modern passenger engine will have a total heating surface 50 per cent larger than this, and a freight engine 30 per cent. For an example, assume 40 per cent: Then, $2301 \times 1.40 = 3221$ sq. ft. for total heating surface and $38.2 \times 1.40 = 53.5$ grate area—which will be seen to be a very usual example. The heavier boiler has given us more adhesive weight and by means of higher pressure we are doing more work with the engine, and since the relative proportion of grate area is the same it will be noted that the rate of combusion per sq. ft. can hardly be much lowered. Where the trouble appears to arise, however, with this new boiler is that but from 4.5 to 6 per cent of its total heating surface is in the firebox, whereas the old boiler had from 8 to 10 per cent in the box, which the '97 report called for as desirable.

An inspection of the boilers on a couple of the last ten-wheelers built on the old style, with narrow deep boxes, extending down between the frames, reveals the firebox heating surface to comprise 9 per cent of the total. In 36 locomotives of all types, built in the years of 1900, reveals 23 boilers having narrow fireboxes placed above the frames. The per cent of total heating surface in the firebox of these averages but 8.4, while the 13 wide boxes average but 6.5 per cent, counting in the heating surface of arch tubes.

Since that time the percentage of total heating surface placed in the firebox has been steadily reduced in both types, and to this fact alone would seem to be the reason for the call for a rapidity of circulation which it is hardly practical to obtain in a locomotive boiler. It may be argued that the Wootten boiler, burning anthracite coal, has not given so much trouble, and that it has been in service many years, its shallow box transmitting an equivalent amount of heat. An inspection of 10 old-style Wootten boilers reveals a firebox percentage of 7.9 per cent, 4 others, with combustion chambers, 10.6 per cent, 9 modern Woottens, 7.6 per cent, all of which is greater in amount than any of the bituminous-burning wide boxes. Though it may be said that there seems a tendency to stint the percentage of firebox heating surface in these boilers also, the results of which will very probably show up in as grievous a manner as is at present true of the bituminous-coal burning examples.

I would like to say in this connection, however, that as the water is very good in the districts where these Wootten boilers are used, the reduction of the amount of firebox heating surface will not work so much harm as would be in evidence in bad water districts. In fact this will be true of all boilers if we consider for a moment the detail of the difference of action between a good water and a bad water—the reason why a boiler which keeps tight in a good water district will immediately start to leaking badly if transferred to a bad water district.

Aside from the matter of incrustation, a bad water expresses itself by a tendency to prime, or foam to a greater degree than is true of a good water. This indicates that it is what one might term lighter than a bad water—it boils away from the firebox more readily—does not lay up against the sheets like a good water does—indicating that the insulating sheet of steam between the sheets and the solid water (where the boiler is being worked hard) is of a greater thickness or exists to a greater extent, with a poor water than with a good water. (The existence of this sheet of steam between the sheets and the solid water has been proved on the Santa Fe in the well known gage cock tests.) The greater thickness of this sheet of steam in a bad water means that the firebox and tube sheets are not kept so near the temperature of the water as is the case where a good water is used—in other words the sheets become hotter, are overheated to a greater extent—which expresses itself in a greater degree of expansion and greater distortion of joints (such as those of the tubes with the tube sheets or staybolts with the side sheets) which tension has been adjusted while the boiler was cold. Now when the engine is shut off after having been worked hard and the temperature of the firebox is lowered through the fire being allowed to die down, practice has shown that where the amount of distortion (consequent upon expansion) has taken place to the degree encouraged by bad water, there is not an entire return to the tightness of joint which existed previously and there is a consequent leakage. Or, in the case of side sheets these distortions express themselves in cracking. Hence where bad

water is used there is more necessity for an amount of heating surface in the vicinity of the fire in order to reduce the intensity of duty which tends to force the water from contact with the sheets.

Right here the whole thing may be summarized as follows: That in all cases where the boiler is worked up to near its capacity, a layer, or sheet of steam develops between the firebox sheets and the surrounding water. The thickness of this sheet of steam determines the temperature to which the firebox sheets will attain above that of the surrounding water. Under favorable conditions this layer of steam is so thin as to be of no practical consequence and the temperature of the firebox sheets will be kept to approximately that of the water. Where, however, from any cause unfavorable conditions permit the thickness of this layer of steam to increase, the firebox sheets will become heated to a considerable degree above that of the surrounding water; the ultimate temperature attained depending entirely upon the amount of increase in the thickness of the layer of steam. The character of firebox defects proves this.

The thickness of this layer of steam is increased by: poor water, poor circulation and an inadequate amount of heating surface, and since the heat is more intense as we approach the firebox, my contention is that the amount of heating surface in the firebox itself is a factor. In other words, I believe that, using the same water in the B. & O. and Frisco boilers here noted, the tube and side sheets of the Frisco boiler will at times become heated to a considerably greater degree above that of the temperature of the surrounding water than in the case of the B. & O. boiler. The facts could easily be ascertained by inserting fusible plugs of various melting points in the side and tube sheets, and in obtaining from suitably inserted gage cocks the relative thicknesses of the steam layers mentioned.

Amelioration of the defects would, of course, take the lines of providing good water, better circulation and more heating surface—of which latter it is the object of this paper to induce a consideration as to whether most results would not be obtained by an increase in the firebox end.

It might be of interest to quote a few examples of bituminous-coal burning boilers in line with the argument, as follows:

oad.	Type.	Type of Firebox.	Wt. of Engine	Drivers.	Cylinders.	Pressure.	Total H. S.	Fire Box H. S.	Grate Area.	Sq ft of Tube H. S. to each sq. ft. in Firebox	Per cent. of total H. S. in fire-box	At 10 per ct. of the total the H. S. in firebox would be *	Sq. ft Area of Tube Holes *	Sq. ft. Fire-box H. S. to each sq. ft. of Grate Area.
												Sq. ft.		
C....	2-6-0	Narrow.	169 140	56"	20x28	200	2,462	202	32.5	12.2	8.2	246.2	......	6.22
C....	4 4-2	Wide.	178,600	79"	20x28	200	3,192	175	51.	18.2	5.5	319.2	......	3.43
S. & M. S.	4 6 0	Narrow.	171,600	80"	20x28	210	2,017	200	33.6	14.6	6.85	291.7	7.52	6.00
S. & M. S.	2-6-2	Wide.	174,500	80"	20½x28	200	3 343	151	48.5	22.1	4.5	334.3	7.8	3.12
& O.	4-6-0	Narrow.	170,000	68"	15½ & 26x28	20-	2.805	213	35.	13.2	7.6	280.5	8.07	6.10
isco .	4 6-0	Wide.	189,210	63"	15½ & 26x28	210	2,880	141	44.	20.5	4.9	288.	8.3	3.20

*At 8.2 per ct. the first wide box would have 262 square feet. At 6.85 per ct. the second ide box would have 229 square feet, and the third wide box at 7.6 per ct. would have 219 uare feet.

The first two will be observed to have the same size cylinders and boiler pressures, and have but slight difference in total weight. Yet, in increasing the total heating surface from 2462 sq. ft. to 3192 sq. ft., 30 per cent, the firebox is cut down from 202 to 175 sq. ft., so that instead of a relation of 8.2 per cent of the total, it is only 5.5 per cent. At 8.2 per cent of the total it would contain 262 sq. ft., or 87 sq. ft. more.

If we look at these two boilers from the '97 recommendations: Cu. ft. of two 20x28 cylinders = 10.181 = Vt.

$10.181 \times 3.4 = 34.6$ sq. ft. grate area, and $10.181 \times 205 = 2087$ total H. S.

As the total H. S. of the narrow box is 18 per cent greater than this, the grate area should be 34.6×1.18, or, 40.8 sq. ft. instead of 32.5, or the boiler has 8.3 sq. ft., less grate surface than it should have. This would indicate that the rate of combustion per sq. ft. of grate surface would of necessity be very high, and in consequence the efficiency of the apparently high percentage (8.2) of firebox heating surface will be much reduced.

On the other hand the wide box boiler is 30 per cent greater in H. S. than the M. M.'s recommendations—so that the grate area should be 45.1, whereas it is 51 sq. ft. or nearly 6 sq. ft. more than the recommendation. The percentage of heating surface in the firebox is so low, however, that it is doubtful if the 175 sq. ft. of H. S. in the box with the wide grate is not called upon to transmit a greater amount of heat per sq. ft. than is true of the 202 sq. ft. over the faster rate of combustion in the narrow box. For if we assume the combustive rate of 200 lbs. of coal per sq. ft. of grate surface per hour over the 32.5 sq. ft. in the narrow box, we will have to burn less than 127 lbs. per sq. ft. per hour on the 51 sq. ft. of the wide box to produce any less amount of heat from this grate surface, while we have 27 less actual square feet of firebox heating surface with which to carry away this heat at these rates. So that, as the rate of combustion of the wide box engine is probably more than 127 lbs. per sq. ft. per hour, the evaporative duty of each square foot of firebox heating surface is probably much higher in the wide box than that of the narrow box, even under the latter's most forced conditions.

It may be objected that these locomotives were designed for different services. Let us take the next two—both passenger engines designed to haul the same train, and of similar dimensions as regards leading particulars of other than boiler capacity. In the narrow firebox (L. S. & M. S.) the percentage of H. S. (6.85) placed in the firebox is considerably less than usual (8 to 9), yet in the wide box boiler even this small percentage has been greatly reduced, is actually 49 sq. ft. less in extent in the wide box than in the narrow box. Taking accepted limits, if we argue that the combustive rate which would be required of the 33.6 sq. ft. grate area of the narrow box boiler, to furnish the heating surface provided in the wide box boiler would be impossibly high, then equally, we can argue that the evaporative duty called for in the diminished

firebox heating surface of the wide box is impossibly high. Again, taking, say 180 lbs. of coal per sq. ft. grate area per hr. as a desirable maximum in both cases and consider that the function of the grate is to provide an area on which to derive a required amount of heat from burning of coal, if we find that the 6048 lbs. of coal per hour we are burning (at the 180-lb. rate) on 33.6 sq. ft. of grate area, is not furnishing enough power and so decide to provide a grate area (48.5 sq. ft.) which will burn 8730 lbs. per hour (at the 180-lb rate), there does not seem to enter into the case any reason justifying a reduction of the extent of the firebox heating surface, and for this extent to be the same over the wide grate would require 229 sq. ft. instead of the 151 sq. ft. which has been provided. At this point it may be remembered that consideration of arch-tube heating surface has been neglected, inasmuch as opportunity of its provision exists in both cases. Also the number of boiler tubes does not enter into the discussion, since they depend upon the diameter of shell, which can be made the same in both cases—the sole difference being in the length, which hardly affects the firebox duty where we are considering the amount of heat produced in the firebox—the flue length concerns the amount of heat which is gathered from the gases after having passed the firebox tube sheet.

Considering these two boilers from the standpoint of the '97 recommendations we see that in the narrow box the total H. S. is about 40 per cent greater than that of the recommendations. This would then call for a grate area of 47 sq. ft.., and if the firebox in relation to the grate area accompanies this increase its surface would then be 280 sq. ft. instead of 200, and its percentage of the total heating surface would then be 9.6. The wide box boiler is an increase of 62 per cent over the recommendations—which would call for a grate area of 56 sq. ft. and a firebox heating surface of 321 sq. ft. at 9.6 per cent, or 229 sq. ft. at the present 6.85 per cent of the narrow box. It will here be observed that in this wide box the grate area provided is less by 7.5 sq. ft. than that recommended by the Master Mechanics—if we follow out the percentage of increase in all directions, and it is the argument that in not having followed these proportions we have got the proper relations so distorted that we are having trouble as a result of the unbalanced design. Also, it will be noted, that since the grate area is not any increase over the recommendations, but is really less in extent, it cannot, therefore, be considered that the rate of combustion has been decreased. Except in that the larger boiler will not be called upon to work as hard to supply the cylinders. But as the work these boilers are being called upon to perform is greater than can be obtained from the smaller boilers, it is reasonable to suppose the boiler and its grate area (and consequent combustive rate) is worked at present (especially in winter) just as hard as was the smaller boiler, which proved not to be big enough for the calls upon it.

Another interesting comparison exists in the third pair presented—of locomotives designed for fast freight service and occasional passenger

service—in which the cylinders and steam pressures are exactly the same and the boilers of almost exactly the same amount of total heating surface. Offhand, it will be noted that the same boiler on the same engine in one case contains 213 sq. ft. of firebox H. S., while in the other only 141, so that the latter box has been diminished 72 sq. ft. in providing the wider and larger grate area. As the same duty is expected, the same amount of coal must be burned to provide the necessary amount of heat from which power is derived, yet the extent of the firebox sheets through which the same amount of heat must pass is 72 sq. ft. less in one case than in the other. Is it not fair, then, to assume that the sheets in the wide box will get much hotter than those in the narrow box—under the same conditions of circulation—and hence evidence the result of such greater heat range in distortion, which shows up in leaking tubes, seams and staybolts, cracked sheets and excessive breaking of staybolts?

In regarding these two boilers in particular we will first note that the compound cylinders are equal to 21x28 simple cylinders, and that these, under the '97 recommendations, call for 2301 sq. ft. total heating surface and a grate area of 38.2 sq. ft. The narrow box boiler in this case is 22 per cent and the wide box 25 per cent greater in total heating surface than the recommendations. This would call for a grate area of 46.6 sq. ft. in the B. & O. boiler and 47.7 sq. ft. in the 'Frisco boiler. So that in neither case is the grate area up to the amount desired in the recommendations. If, in the B. & O. boiler we were to raise the grate area to the recommendations of 46.6 sq. ft. and provided the same ratio of firebox H. S. over this increased area we would have a firebox H. S. of 260 sq. ft., which would then be 9.3 per cent of the total H. S. This, in the case of the 'Frisco boiler, even not raising the grate area to the recommendations, would call for 268 sq. ft. H. S. in the firebox. Even providing for the proportion in evidence (7.6 per cent) with the B. & O. boiler, the 'Frisco boiler should have 219 sq. ft. in the firebox, or 78 sq. ft. more than at present.

CONCLUSION.

In the 1902 Master Mechanics' proceedings a report dealing with boilers states: "The important relations in boiler design are those between the power and total heating surface, between the total heating surface and grate area, and between the power and grate area." Also, "The ratio between tube heating surface and firebox heating surface is of no particular value, as grate area controls it to a large extent."

Non-consideration of the ratio of firebox to total heating surface, as unimportant and unobtainable, would seem to partake of the nature of a snap-judgment, for it is obviously useless to provide a grate area that will produce a certain amount of heat, if we do not at the same time provide an amount of firebox heating surface which a practical circulation will keep from becoming overheated. And the character of the complaints against the wide boxes would appear to prove that the lower-

ing of the percentage of firebox to total heating surface has been carried below desirable limits in these boilers.

It is the object of this paper to present this view of the matter and thereby call out discussion of the point. If it is decided that the reasoning is correct—that the percentage of total heating surface placed in the firebox *is* important, then the matter of providing a proportion which will tend rather to 10 per cent than the present tendency to 5 per cent, while retaining the wide firebox that enables the desirable area of grate to be provided—is a subject which can be taken up by more competent hands than the writer's. It can be done—the how is a matter of individual ideas.

THE CHAIRMAN: You have heard Mr. Reilly's paper and he has made some comment as he has read the paper, which is certainly good material for thought, and I trust it will prove so for discussion. Mr. Van Alstyne is a member of the Committee on Boiler Design, I believe, and we would be pleased to hear his comments on the paper.

MR VAN ALSTYNE (C. G. W. RY.): As a member of the committee that made the boiler design report last year, from which the author has quoted to some extent and drawn some inferences, I want to call your attention to one or two points. He says, comparing the troubles that wide fireboxes give with those of narrow fireboxes, that the wide fireboxes give the most trouble. Question 12 on page 14 of the committee's report was "Do you have less firebox and flue troubles with wide grate boilers than narrow?"

Seven say "Yes," eight, no: no appreciable difference.

The answers, which came from all over the country, indicate that there is less trouble with wide firebox than the narrow.

In the second paragraph, page 2, he says, "Is it not logical to presume then, that, aside from the increase in steam pressure, our principal trouble arises from the reduction in the per cent. of total heating surface placed in the firebox, which has accompanied the widening of the grate?" I do not think it is fair to assume that. There is not any question, from the work that the committee did, but that the high pressure narrow firebox of equal capacity and steam pressure as the wide firebox gives a great deal more trouble from cracked side sheets and broken stay bolts.

PROF. WILLIAM F. M. GOSS (Purdue University): What is that? Will you kindly state that again?

MR. VAN ALSTYNE: I said that the narrow firebox, say the 42-inch grate on top of the frame having equal capacity to that of the wide firebox, is much more troublesome than the wide firebox.

A little further down the paper says that "If this freer circulation is not furnished, the sheets will become overheated and the observed leaking and cracking is the result. Equally obvious is it then, that the most practical remedy would seem to lie in increase in the amount of heating surface in the firebox to a percentage which would not

demand so high an evaporating duty of the sheets, etc. As I understand it, the amount of heat transmitted to the water surrounding a firebox is proportioned to the difference between the temperature in the firebox and the temperature of the water. Any firebox will evaporate water in proportion to its surface and whatever heat that firebox cannot transmit to the water, must necessarily be transmitted through the flues. Assuming a given coal consumption in a boiler of any ratio of firebox and flue heating surface, a certain amount of heat is generated and a certain amount exhausted through the stack, the difference being taken up by the water. If the firebox can take heat only in proportion to its surface the flues must take the rest, and there is no reason for supposing that the smaller the firebox in proportion to the total heating surface the more work it does.

Again the writer of the paper says: "The heavier boiler has given us more adhesive weight, and by means of a higher pressure we are doing more work with the engine, and since the relative proportion of grate area is the same, it will be noted that the rate of combusion per square foot can hardly be much lowered." The information that the committee got on that subject was that those who had obtained definite information had found that the large grate is more economical than the small grate. There is no heavy engine having a large grate or a small grate that is not more economical of coal per ton mile than a small engine, and if the grate area has increased as rapidly as the tractive power, then it follows that the large grate is considerably more economical of coal, and that is undoubtedly the case. In fact, as I understand it, the only reason why a large grate is more economical of coal than the small grate, is because of less draught per square foot of grate area, which throws less fuel out of the stack.

It seems to me that this question of leaky fireboxes may be summed up in two words, namely, "design" and "treatment." By design I mean liberal water spaces, widening from the bottom upward, flat side sheets and side sheets inclined inward toward the top so that steam can quickly leave the sheets.

Also free communication between barrel and firebox so that water can easily pass from barrel to water legs. Easy curves at mudring corners and fire-door opening are necessary. Firebox troubles I believe to be purely due to insufficient circulation. Poor circulation is due to contracted water spaces, steam pockets, and water too highly impregnated with solid matter.

Of equal importance with design is the treatment, or care, of boilers, and by treatment I mean the avoidance of the concentration of solids in the water to such an extent as to be injurious to the firebox.

The greater the amount of solid matter contained in the water the more rapidly the solids become concentrated in the boiler. Incrusting solids are not alone to be feared, because rapid incrustation can be prevented, but you cannot prevent burned side sheets that are surrounded with water highly concentrated with solids.

Concentration can be prevented by water purification, or by systematic blowing off, or, in extreme cases, by a combination of both, and I am inclined to think that water purification should not be gone into until the possibilities of the blow-off cock have been exhausted. Recent observation and experience have convinced me that the advantages to be gained by the liberal use of the blow-off cock are not appreciated, and I believe there are a good many waters with which water purification will fail, whereas the blow-off cock will succeed, and very few waters are so bad but that a combination of both will make them usable.

Leaky flues are not so easily cured by the same treatment because there are other causes in addition to those previously mentioned which cause them.

MR. REILLY: I do not quite understand that term, "concentrated." What do you mean by "concentration of water"? How do you mean that it is concentrated?

MR. VAN ALSTYNE: I mean that if you start out with a water having say thirty grains per gallon and keep feeding it into the boiler, you are going to evaporate the water and keep the solids in and in time you have a very highly concentrated water in the boiler.

MR. REILLY: That is, a sedimental concentration?

MR. VAN ALSTYNE: Yes.

PROF. W. F. M. GOSS (Purdue University): Mr. Chairman, it is my understanding that one argument of the paper is to the effect that in the development of the modern locomotive boiler, the area of fire-box heating surface as compared with the total heating surface of the boiler has been reduced, and that as a consequence extra duty is imposed on the fire-box heating surface, hence, troubles complained of, etc. Am I right in this statement?

MR. REILLY: Yes.

PROF. GOSS: Well, I do not think the argument is a good one. Employing the term used in the paper, the "evaporative duty," that is put upon a given area of metal, is the result of the difference in temperature between the two sides of the metal. The evaporative duty will increase when the difference in the temperature between the two sides is increased. Now, I do not understand that those changes in the proportions of boilers which Mr. Reilly emphasizes, have resulted in an increase of furnace temperature, which alone can result in increased evaporative duty. We know that, other things being equal, the rate of combustion is greater on a small grate than on a large grate, and the higher furnace temperature results from the higher rate of combustion. When we burn 200 pounds of coal per foot of grate area, we have a hotter fire than when we burn 100 pounds of coal per foot of grate area, so that with the small grate, the hotter the fire, the higher the temperature in the firebox, and consequently the higher the evaporative efficiency. It seems to me, therefore, that the argument to which I have called attention does not constitute a very good plank in a reform platform.

Speaking upon the general question, there are, it seems to me, several reasons why there should be more trouble in maintaining a large firebox than a small one. One of these arises from the fact that when a fire is thin, it is more difficult to maintain it uniform in thickness than when it is thicker, consequently, the fire on a large grate which must of necessity be thin, is more difficult to maintain than the fire in a small grate which may be thicker. Portions of the large grate are often insufficiently covered, and blasts of cold air coming through lead to local contraction, and trouble sooner or later follows.

Another handicap under which the wide grate must withstand is the loss of fire which occurs when the tubes leak. A leak which will make but little impression on the thick fire of a narrow grate will put out a thin fire of the wide grate—not entirely out, of course, but out in spots which can not be rekindled as long as the leak lasts.

It seems to me, also, that there is difficulty with the wide firebox, arising from the extent of the sheet. I have had some experience in maintaining galvanized gutters on buildings, and I find there is no difficulty in keeping a gutter tight the length of which does not exceed forty or fifty feet, whereas a gutter one hundred or more feet in length, as ordinarily constructed, can not be kept tight. The expansion and contraction strains then become so great that the joints will pull apart. Now, in increasing the size of the fire-box, we have larger sheets and like the larger galvanized gutters, they pull. Such difficulties as may arise from conditions which I have described are, I believe, in the nature of necessary evils which attend the case of the wide firebox.

MR. H. A. FERGUSON (J. T. Ryerson & Son): I am here rather unexpectedly, and am not familiar with the paper, excepting as I heard the gentleman read it.

I can only say that I agree entirely with Mr. Van Alstyne, especially where he speaks of the design of the firebox overcoming the trouble, rather than the relative difference between the small box and the larger one.

Mr. Reilly has another so-called "plank" in his platform, being the difference in the thickness of the film of steam having a large bearing on leaks, and that is undoubtedly true, but again, what Mr. Van Alstyne says about sloping the inside sheet so that the steam is relieved, would certainly overcome that trouble.

THE CHAIRMAN: Gentlemen, there are quite a number of practical railroad men here who have undoubtedly been up against it, so to speak, with leaky fireboxes in their roundhouse. We will be glad to hear from any or all of you.

MR. A. BEMENT: There is one thing that has not been considered, that can have an effect on the life of the fireboxes with large grates. It is the condition of combustion, or, in other words, the initial temperature. I am not now prepared to say whether the engines with large grate areas have proportionately more or less surface in the firebox, but having had experience with both large and small grates, have found

that the accumulation of ashes in thickness is not so rapid as with smaller grates. The effect of an accumulation of ashes and the formation of clinker on the grate is to prevent uniformity of the air supply, resulting in carbon monoxide, and allowing escape of hydrocarbons, which is a waste of heat. For this reason the initial temperature, or, in other words, temperature of the fire, is lower.

The metal of the firebox offers a certain resistance to the flow of heat through it, which results in raising its temperature, and as this resistance increases with the flow, the result is that it becomes proportionately hotter. The rate of flow or transfer of heat being dependent on the elevation of temperature, it follows that the temperature of the sheets and the amount of water evaporated per unit of surface is greater or less according to the elevation of temperature. For this reason it would be possible for the sheets of the fireboxes with relatively large grates to suffer more than those with small grates, assuming that the water supply is the same in each case.

As Professor Gross has mentioned, there is more danger of the fire of the large grate getting uneven, and air entering through holes, the effect of which is to cause lower initial temperature. This means that the range of temperature in the fireboxes with large grates is both higher and lower than with the small grate, which has a greater effect on the metal of the large firebox. It is, however, probable that a more liberal water supply with the large boxes, compensates for the effect of higher initial temperature.

One of the speakers has called attention to the superior efficiency of the boilers with large grates, owing to the less quantity of fuel carried out of the stack, on account of the lower draft required. There is another reason for it—that of higher initial temperature, as above mentioned.

The initial temperature may be determined by the formula—

$$\text{Initial temperature} = \frac{\text{Heat produced by the combustion.}}{\text{Weight of the gas} \times \text{its specific heat.}}$$

The efficiency of the cooling effect is dependent on the capacity of the cooling surface, or, in other words, the heat absorbing surface of the boiler, and the initial temperature, and may be illustrated by the equation—

$$\text{Efficiency} = \frac{R^1 - R^2}{R^1}$$

R^1 being the initial rise in temperature above the cooling medium; or temperature of the fire.

R^2 the final rise in temperature above the cooling medium; or temperature of escaping gases.

The cooling medium being the water in the boiler, at the temperature due to its pressure.

With boilers in general the rise in temperature would be measured above that of the air and fuel supply, but for comparison the measure-

ment should be taken above that of the cooling medium, because pressures are different. An exact comparison of boilers requires that the quantity of heat, and its initial rise in temperature be the same, then the final rise shows the relation between the two boilers as expressed in the equation.

MR. WILLIAM FORSYTH (Railway Age): I think Mr. Reilly has done a good work in calling attention to the changes in proportions of the modern locomotive boilers, and his paper brings up a number of interesting questions, some of which unfortunately we cannot answer because we have not definite data, but we have general principles which apply and which have been stated already, and I am sorry that I cannot agree with the general conclusions of the paper. The fact that the firebox heating surface has what might be called a normal absorption of heat is shown by the fact that if you brick up the box so that there is very little of it left the remaining portion of it will keep on absorbing and it will not be overheated any more than the whole box as it was, and that experience which has been had with boilers where there is no firebox at all, where the firebox in some cases was entirely bricked up, as in the Lentz boilers and in the case of the original stationary boilers at the Juniata shops where there was nothing but tube heating surface and the tubes absorbed all the heat, and as good economy is thus obtained from boilers which have entirely tube heating surface as from those which have a firebox.

The gentlemen who have spoken before have pointed out the fact that firebox absorption is probably normal, and I think I should go further than that and say that even if the temperature of the firebox was greater, that the troubles of the firebox leaks and overheated sheets would not necessarily be caused by that for this reason: That the constant difference between the temperature of the two sides of the firebox sheet in stationary boilers need only be about two degrees Fahrenheit in order to do the work expected from them, and in locomotive boilers I should think that a difference of twenty or thirty degrees would be sufficient to obtain all the work that has ever been obtained from the most intense performance of locomotive boilers, so that if the circulation is good there should be no tendency to overheat the sheet, no matter how hot we would make the fire in burning coal.

The author seems to think that the proportions recommended by the master mechanics' committee of 1897 are correct ones and that the heating surface of the firebox should be about ten per cent of the total heating surface, and that that should not be departed from very largely, as they have been in modern boilers; but the fact of the matter is, the committee which made that report dealt with boilers which they had at that time, and which they regarded as good practice, and they made the report in accordance with that and without any other reason. There is no particular reason why the ratio of firebox heating surface should be ten per cent, or that it should be five per cent or twenty per cent, and for that reason I think that these changes which have been

made in these ratios should have very little effect on the temperature of the sheets or on their leakage.

MR. G. W. FARMER (A., T. & S. F. Ry.): In connection with what has been said I think the point which Professor Goss brought out relative to the difference between the smaller boilers and those which have been built later is very good. That is, that the small defects which existed in the smaller boiler are aggravated and increased in dealing with the larger boilers, and I would also like to inquire if it has been the practice on many of the roads I know that it has been on some—to test boilers when they go to the shop for overhauling—that is, the hot-water pressure, say something like fifty pounds above the boiler pressure carried, and also keeping track of the scale and mud which is removed from the boiler when the flues are taken out, including that which is on the flues themselves.

THE CHAIRMAN: There is one feature of leaky fireboxes that I would like to call attention to, and that is the change made by the use of the brick arch. Before the brick arch was so generally used in fireboxes the sheet which first gave out, started to leak, cracked and made the most trouble was the flue sheet; generally the next in order to play out was the crown sheet; after that the side sheets and lastly the door sheet; but since brick arches have been generally applied to locomotive fireboxes it has been my observation that the order of deterioration has been reversed. As a rule the first sheet to give way and crack is the door sheet, either around the door hole or in the corners; that is usually followed by the side sheets, then the crown sheet, and lastly the flue sheet. That, in bad-water districts, has led me to believe that the brick arch is more expensive than the firebox without the brick arch. The reason for that is that in bad-water districts there is always bound to be a great deal of boiler work on flues, staybolts and firebox sheets, and the coal saved by a brick arch will be more than offset by the additional cost for boiler work and loss of use of the engine while the boiler work is being done. This is aggravated by the length of time it takes for a brick arch to cool off so that a man can get on top of it to work on the flues or crown stays, and in some bad-water districts I have done away with the brick arch altogether, and have thereby cut down our engine failures from leaky fireboxes at least seventy-five per cent. I would not go on record as being in favor of not using the brick arch where there is good water, but I am satisfied that it is an expensive luxury where there is a great deal of boiler work on account of bad water.

MR. VAN ALSTYNE: Professor Goss' explanation of the reason why flues in wide fireboxes are more troublesome than they are in narrow fireboxes is one that I never heard before, and while that may be the reason I would be rather inclined to think that the trouble is more due to the fact that wide fireboxes as a rule are shallower than the narrow, and the shallow firebox tends to produce leaky flues in two ways: First, in that it brings the fire up close to the flues and gets the intense heat of the short white flames to a greater number of the flues; and second,

because there is less depth of waterleg to keep the cold water away from the flues. I think there is ample evidence to show that if there was less circulation around the tubes immediately ahead of the back flue sheet there would be less trouble with leaky flues. A wider space between the tubes is undoubtedly beneficial beyond the back flue sheet, but not at the flue sheet. It is my observation that practically all flues that leak are below the center line, and I think it is due, as I have explained, to the intense heat of the short, white flames, and also to the fact that the cold water stands at a high depth in the shallow firebox.

The experience I have had with various spacings of tubes indicates to me that the wider the spacing the better the results will be; but as far as I have gone, that is an inch and a half bridge, it is certainly not a cure for leaky flues.

MR. PETER H. PECK: I think Mr. Van Alstyne is right in what he states about shallow fireboxes. We had ten shallow-firebox engines a number of years ago, and there was so much leakage from the flues that the engines would not steam. On the engines with the deeper firebox we do not have so much trouble. We are using a kind of drop grate, and we changed the drop grates from the front to the rear end of the firebox in order to avoid the cold air; and that had a good effect on the flues.

MR. FORSYTH: In regard to what Professor Goss says about the leakage of the wide firebox on account of the long sheet, Mr. Reilly says in his table that the area of the modern firebox with the wide box is less than that of the narrow ones; that in one case it was 72 square feet less. Here is one narrow box with 243 square feet and a wide box with 141 square feet. Now, I would like to ask the Professor how he finds the sheet longer in the wide firebox than in the narrow one?

PROFESSOR GOSS: I am not attacking those figures. I merely assumed that the wide fireboxes have greater furnace area, or heating surface, than the narrow firebox. If I am wrong in that there is nothing in my argument.

THE CHAIRMAN: Gentlemen, if there is no further discussion we will ask Mr. Reilly to close the debate.

MR. REILLY: The object of the paper has been accomplished, in having brought out an expression of opinion as to whether the extent of heating surface in the firebox should not be considered as well as the matter of better water circulation, especially where the water used is such as to give trouble from leaking. You do not seem to think so, but none of the arguments advanced against it seems to me to afford sufficient reasons for ignoring this factor. I am particularly impressed with this belief because of the results obtained in foreign practice, where boilers are always given more firebox heating surface than is at present customary in this country; in fact one English line has placed thirty per cent of the total heating surface in the firebox of more than 100 locomotives with excellent results. The English and French certainly get more out of their boilers than we do; they use smaller boilers than we do with

the same size of engine and, although of course their coal and water is generally better than ours, I cannot account for the results they get out of these boilers unless it is because of their greater proportion of firebox heating surface, for the tube spacing and other proportions are about the same and the water spaces in the legs are even smaller than we use.

Referring particularly to the contentions advanced against the proposition of the paper, I would say that the replies as to the comparative amounts of trouble experienced with the two types of boilers are conflicting to nearly an equal extent, as eight is to seven, with four nil. In the absence of specifications in each case as to the character of water used there can be no inference drawn. The same applies to the second objection of Mr. Van Alstyne; but since both types of boilers leak, and both types have had their firebox areas gradually reduced, the question at issue is, would they not both be benefitted by an increase in the extent of the firebox area—the wide box particularly because of its greater reduction in this particular? His contention concerning the evaporative duties of the sheets, rates of combustion, etc., I would answer in this way: The boilers in the last two examples of locomotives are practically precisely similar in all respects, save that of grate area and extent of firebox heating surface. The object in providing the wide grate in the Frisco boiler was to provide an area on which more coal could be burned in order to generate heat—the smaller grate area in the B. & O. boiler having proved insufficient as to supply the ultimate capacity of the engine. The lowered rate of combustion was an incidental advantage, yet this consequent lowered rate of combustion causes the gases to be drawn less rapidly through the tubes and, since these tubes are precisely the same in both cases and a greater total amount of heat is generated on the larger grate, which must be absorbed by the same sized boiler, does it not stand to reason that the heating surface of the firebox will be compelled to absorb a greater proportion of the heat in the wide than in the narrow box? And since the wide box in this example has but 3.2 sq. ft. of heating surface to each sq. ft. of grate, as compared with the 6.1 per sq. ft. of grate in the narrow box, will not the individual duty of each sq. ft. of sheet be greater in the wide box of the Frisco boiler? Now, this increase in the heat transmissive duty per sq. ft. of fire box sheet will not cause any rise in the temperature of the sheet above that of the surrounding water so long as the circulation is sufficiently rapid to carry away the particles of water as fast as they are turned into bubbles of steam. (Bad water alone requires a more rapid circulation because of its tendency to bubble away from the sheet faster). In the absence of a requisite rapidity of circulation the particles of steam are not carried away freely and promptly replaced with particles of water. The result is the formation of a layer of steam between the sheet and the water, and, as this layer of steam is a poor conductor of heat, it acts as a heat insulation between the sheets and the water, with the result that the temperature of the sheet

is not now kept to that of the water, but rises above it in the degree that this film of steam becomes thicker, or, in other words, to the degree in which the circulation is faulty. Since the character of firebox defects indicates that such a state of affairs often arises, and the rapidity of water circulation necessary to obviate it has proved difficult to provide, particularly where bad water is used, does it not seem worth while considering an attempt to reduce the call for so fast a circulation by reducing the duty per sq. ft. of firebox heating surface by increasing the extent of such surface?

Where the relative greater economy of the wide grate is mentioned, I do not think the idea has been caught—there is no question of the economy of the wide box, which has a sufficient grate area, over that of the narrow box, which has not enough grate area, where we are dealing with modern sized engines. In considering the rate of combustion we must deal with the amount of work performed as well as the extent of grate area. To do a certain amount of work we must secure a certain amount of heat and so far as the purposes of this paper are concerned, it does not matter whether this amount of heat is obtained from the coal being burned on either a small or a large grate, the effect of the lower rate of combustion with the large grate has already been explained. It may be said incidentally, however, that the large wide-box engine cannot be called upon for an amount of work in proportion to its grate surface that the old, small engine (old 16 x 24 eight wheeler) with a proportionate amount of grate area could, because a human being cannot put the 8,000 or more pounds of coal per hour into the firebox that the 48 sq. ft. of grate area would call for at the 180 lbs. rate. Hence the large engine is compelled to be worked at an economical rate. I agree with Mr. Van Alstyne in his reliance on design to help out the matter of subsequent treatment, in seeking to avoid leakage. It is a matter of design with which the paper deals. The avoidance of concentration of sediment is also in line with the present agrument, for such concentration produces bad, water, whose effects are mentioned. As to the side sheets sloping in the wide box so as to assist the steam in escaping from the sheets, the paper states that in all ways the wide-box boiler seems to assist circulation, and yet gives as much or more trouble than the narrow one, and the reason for this apparent anomaly it is the purpose of this paper to set forth.

Replying to the first point of Prof. Goss, on evaporative duty, I will say again, that in the particular and sole case of the side and tube sheets of a locomotive firebox, it is not a question of the difference in temperature between the two sides of the sheets. The point is that when the evaporative (or heat transmissive) duty required per sq. ft. of sheet exceeds the amount for which a certain rate of water circulation will provide, then there arises a heat-insulating layer of steam between the sheet and the water and it is then a question of the percentage of generated heat which is thereby held in the sheet instead of passing on through this layer of steam into the water, and in the

degree that this percentage of heat is compelled to be taken up by the sheet instead of passing on freely into the water, will the sheet become heated above the temperature of the water existing beyond the layer of steam. His second point I have already answered in saying that the larger grate generates a greater total amount of heat and, since the tube area is the same and the rapidity of the exit of the gases is lowered by the lessened rate of combustion, there will remain in the firebox an increased proportion of the heat to be taken up by it as well as the tubes, and, since the extent of firebox heating surface has been lowered, there will be a subsequent increasd transmissive duty per sq. ft. of sheet—the effects of which have already been noted.

The first and second "handicaps" mentioned simply add to the distortions to which the smaller extent of firebox area is compelled to sustain. As to the third handicap, I will say that so far as locomotive firebox side sheets go, I have never had any more trouble from a long side sheet than with a short one, except in the matter of circulation. So long as the water circulated freely about the sheet they gave no trouble, but when the water was for any reason unable to get to the sheets, they cracked, regardless of whether they were long or short sheets.

The objections of Mr. Fergusson have already been covered in previous remarks, and Mr. Bement's remarks are practically in line with my argument. As the first portion of Mr. Forsyth's remarks relate, I believe, to the Lentz boiler, I can but express an unfamiliarity with its design or results in service and hence am not in a position to say whether its failure to be in general use arises from defects traceable to the diminishment of firebox heating surface he mentions. Neither can I admit into the argument the consideration of stationary boilers, of whose peculiarities one would need complete information to discuss, for instance, if the all-tube boilers mentioned are water-tube boilers, their heating surface is practically all firebox heating surface instead of none. His next point is covered in the first part of the reply to Prof. Goss. As to the reasons for the basis taken by the 1897 committee in their recommendation of 10 per cent., I will say that it is appreciated the committee went by the practice then extant, but my idea is that the service rendered by those boilers was better than that obtained in the modern boilers, in which this 10 per cent. has been cut in two, and that we would have done better to increase this 10 per cent. than to decrease it, this for the reasons given throughout.

Replying to Mr. Farmer—I do not think the increase of defects would become apparent if these increases in size had been made equally in all particulars. I take the remarks of Mr. Barnum concerning the effect of brick arches, to prove the very basis of my argument, for the shifting of the locality of the troubles by this means shows a corresponding shifting from one vicinity to another of an excessive evaporative duty which expresses itself as mentioned by Mr. Barnum.

I agree entirely with Mr. Peck and Mr. Van Alstyne concerning the

bad effects of the shallow box bringing the bed of fire so near the tubes, but I cannot agree that a derivable deduction is that a lessened circulation is desirable immediately in front of the tube sheet, and further will say that I do not coincide with the statement that it is the tubes below the center line which leak most. In fact my observation has been just the reverse, except where the spaces between these lower tubes have become clogged with mud and incrustation. In the absence of such increased amount of incrustation or amount of mud in this vicinity, it has been my observation that the upper tubes exhibit a greater tendency to leak than do the lower ones, and if we consider the phase of circulation in this vicinity it is reasonable that this should be true. If the lower tubes are giving more trouble from leaking than the upper ones, it is the general custom in bad water districts to take out an inverted V of from 60 to 100 tubes, in order to clear out the mud and incrustation in this lower portion of the boiler.

I appreciate it is not reasonable to expect an immediate reversal of sentiment upon the points brought out in the paper, but I cannot help thinking that the more one considers the proposition, the more reasonable it appears. I thank you for the attention which has been given me.

MR. F. D. FENN (Crane Co.): I would like to ask what the water leg proportions are. Now, for instance, we have five inches of water space in the side leg of the boiler in the old fashioned locomotive boiler; how much water space have they in the legs of these large boilers, these wide firebox boilers? Has the area or quantity of water been increased next to the firebox, between the firebox sheet and the outside sheet? To what proportions have they increased the water space?

MR. REILLY: Well, the older classes of boilers only had a two-inch space in the water legs and this is true of much foreign practice yet. Of late years this has been increased to three inches and when we come to the wide firebox we increase it considerably, as a rule to four inches and now we are endeavoring to get better circulation by increasing it to four and a half and five, and even six inches. The last new decapods on the Santa Fe have a six-inch water space on the sides. Of course, the obect in that is to get a better circulation of water and help the wider spacing of the tubes to perfect the water circulation.

THE CHAIRMAN: There is another paper, gentlemen, on "Specifications for Boiler Tubes." I will ask the Secretary to read it.

THE SECRETARY: This short paper or rather circular of inquiry is presented with the hope that information may be obtained that will be of assistance to the Committee of the Master Mechanics' Association in revising the present specifications. The paper is as follows:

SPECIFICATIONS FOR BOILER TUBES.

At the last convention of the American Railway Master Mechanics' Association, a committee was appointed to revise the specifications for boiler tubes and to provide for steel tubes as well as iron tubes.

The committee to which this task is assigned, asks the members of the Western Railway Club who have to do with the handling of tubes, to aid it to the extent of making suggestions as to wherein these specifications may be improved upon, and new specifications for steel tubes proposed.

The present specifications and tests of the Association for iron tubes are as follows:

IRON TUBES—MATERIAL.

"Tubes to be made of knobbled hammered charcoal iron and lap-welded.

DIMENSIONS AND WEIGTHS.

Tubes 2 inches, outside diameter.

.095 inches thick and weight at least 1.91 lbs. per foot.
.110 inches thick and weight at lesat 2.19 lbs. per foot.
.125 inches thick and weight at least 2.47 lbs. per foot.
.135 inches thick and weight at least 2.65 lbs. per foot.

Tubes 2¼ inches, outside diameter.

.095 inches thick and weight at least 2.16 lbs. per foot.
.110 inches thick and weight at least 2.48 lbs. per foot.
.125 inches thick and weight at least 2.80 lbs. per foot.
.135 inches thick and weight at least 3.01 lbs. per foot.

SURFACE INSPECTION.

Tubes must have a smooth surface, free from al laminations, cracks, blisters, pits and imperfect welds. They must also be free from bends, kinks and buckles—signs of unequal contraction in cooling or injury in manipulation—and must be of uniform thickness throughout, except at the weld, where .015 inch additional will be allowed, perfectly round and cut to exact length ordered.

PHYSICAL TESTS.

1. Strips one-half inch in width by six inches in length, planed lengthwise from tubes, after being heated to a cherry red and dipped in water at 80 degrees Fahrenheit, shall bend in opposite directions at each end, without showing cracks or flaws; and when nicked and broken these must show a fracture wholly fibrous, or a test in a testing machine may be substituted for this.

2. Sections of tubes 12 inches long—five inches of which shall be heated to a BRIGHT CHERRY RED IN DAYLIGHT—when placed in a vertical position and a smooth-turned tapered steel pin at a BLUE HEAT is driven in, by "lap" blows with a 10-pound hammer, must stretch to one and one-eighth times their original diameter without split or crack. One tube to be tested, as required in paragraphs 1 and 2, in each lot of 250 tubes or less.

3. Tubes must expand, turn over tube plate and bend down without flaw, crack or opening at weld.

HYDRAULIC TESTS.

Each tube must be subjected, by the manufacturer, to an internal test of not less than 500 lbs. to the square inch.

ETCHING TESTS.

In case of doubt as to the quality of material, the following tests shall be used, namely:

A section of tube turned or ground to a perfectly true surface, polished with fine emery paper, and free from dirt and grease, to be suspended in a bath of

Water..............................	9 parts.
Sulphuric Acid.....................	3 parts.
Muriatic Acid......................	1 part.

The bath should be prepared by placing the water in a porcelain dish, adding the sulphuric acid and then the muriatic acid. Chemical action is allowed to continue until the soft parts are sufficiently dissolved so that an iron tube will show a more or less finely ridged surface, with the weld very distinct.

GENERAL REQUIREMENTS

Each tube must be plainly stenciled "Knobbled Hammered Charcoal Iron" and "Tested to 500 Pounds," and tubes must be so invoiced. Each tube must also be subjected to careful surface inspection; and those measuring one-sixty-fourth of an inch over or under the diameter ordered shall be rejected.

The above specifications were adopted in 1895, so that they can hardly be considered up-to-date.

STEEL TUBES.

The Association does not have any specifications for steel tubes. It would, therefore, be in order for you to give your views as to proper specifications, for the information of the committee.

The question of steel tubes for locomotive boilers has not received a great deal of attention; at least there is not much data available. There have been a number of experiments made with them, but their general introduction has not attained very large proportions. Why they are not more generally specified is a subject on which it would be interesting to hear the views of the members. In an editorial in a recent issue of The Railway Age, the statement is made that "steel has gradually taken the place of iron in almost every other locomotive detail, resulting in decided improvement, and the metallurgy of steel has advanced to such a stage in the production of pipes and tubes that we see no reason why steel tubes should not gradually supplant those of iron in locomotive boilers."

It would be of assistance to the committee to know:

(1) Are you using the above specifications for your boiler tubes?

(2) As a result of your use of these specifications, or modification thereof, have you any suggestions to make as to their proper revision?

(3) What have you to suggest for a specification for steel tubes which will secure satisfactory materials?

(4) Have you observed any difference in the extent of pitting of iron and steel tubes in similar service?

(5) What is the best practice in regard to material for safe ends?

THE SECRETARY: I might add that Mr. William Forsyth is a member of this committee. He is here today and I know he would be glad to have the suggestions of any of the members.

THE CHAIRMAN: Mr. Forsyth, perhaps if you will direct the thoughts of the members, they will be stimulated to express themselves later.

MR. FORSYTH: From the replies which the committee has received to their circular on this subject, we are convinced that the specifications of iron tubes are about right, with the exception of the second paragraph relating to the test by drift pin, and from what we learn from these replies, we would rather favor leaving that out altogether. Then, with the specifications, omitting the second section, we would think that the specification is sufficient to secure a good iron tube, and what we want to find out now is, what is the real difference between a steel tube and an iron tube, and what should be added to the specifications in order to secure good material in the steel tube. We have asked a number of questions at the end of the circular, and if any of you can gives us replies to these, we will be glad to have them.

THE CHAIRMAN: Mr. Wickhorst, will you give us your experience on this subject?

MR. M. H. WICKHORST (C., B. & Q. Ry.): Mr. Chairman, I have nothing to say specially as regards the specifications for iron tubes; they seem to be sufficient to get good material, and as regards steel tubes, the C., B. & Q. has not used them. The reason for that is that some years ago the matter was studied into a little, but we were not very successful in making welds of the steel tubes, that is, in the way we worked it we did not have great success, at any rate not sufficient success in making a weld of a safe end. It is probable that steel tubes of such quality can be furnished now and possibly by the use of a different method of welding, steel tubes can be used with entire success. I would like myself to hear from members who have been using steel tubes extensively as to that point.

THE CHAIRMAN: Mr. Farmer, will you tell us what the Santa Fe is doing in this line?

MR. FARMER: I am sorry I cannot tell you whether they are using steel tubes or not. As far as I know they are not using any.

THE CHAIRMAN: Mr. Fergusson, can you give us any information?

MR. FERGUSSON: I know that there are a great many steel tubes being used by railways; and they seem to give excellent service. There are a great many roads that are safe ending steel safe ends on an iron tube, and get very good results. As a usual thing, they use a little heavier gauge than the body of the tube. As far as the manipulation of the steel tube is concerned there is not any great difficulty; it is a very easy matter to weld them if you have the proper appliances and they seem to stand up better than the average grades of iron tube. If I am not mistaken, the Great Western is still using some steel tubes. Mr. Van Alstyne may be able to tell you about that.

MR. VAN ALSTYNE: I cannot answer any of these questions of the committee. We use steel tubes and we imagaine that they leak more than the iron tubes. I have not any definite information and I cannot say positively. So far as specifications for the iron tubes go, I will say that we weld heavy high grade safe ends to an ordinary lighter weight body. That has been our practice for some time. I do not think there is very much difference between the better qualities of iron tubes.

PROF. GOSS: I would like to ask Mr. Forsyth whether there is anything to indicate that the mechanical tests which are applied to a steel tube should be different from those that are applied to an iron tube?

MR. FORSYTH: That is the very difficulty that we find in these replies, that on that subject we did not get any information at all. The tests which have been made in the laboratories of steel tubes are not reported; they do not seem to have formulated any special requirements to aid us in addition to the present specifications.

MR. FERGUSSON: I would advance one thought in connection with that paragraph for internal test pressure of the tube, and ask Prof. Forsyth if there is any difference in the quality of the metal; if there is any reason for using an internal test pressure other than its simple application? It appears that on a great many roads where tubes are tested that it is the universal practice to test them with an internal pressure, whereas of course, the pressure, when in service is on the external surface. I would like to know if it would be worth while to have a specification that would provide for an external pressure rather than an internal?

MR. FORSYTH: I would say that the object of the pressure tests is to show a defect. Of course, if the material is good, the tube will stand the pressure, or a pressure several times greater than the test pressure, and the object of the test is simply to discover a defect, an in solid drawn steel tubes there would be very likely to be no such defect, because there is no weld. I think the external pressure would be hard to apply and I do not think it would have any particular advantage.

MR. GEO. L. BOURNE: Referring to the question of safe ending: I know of a number of roads that are handling from 7,500 to 10,000 flues per month and are using steel ends on steel tubes. They seem to handle them just as fast as they did the iron tubes and in the work of safe ending I believe the steel tube can be handled with just as much safety and just as rapidly as can the iron. I understand the Lake Shore handles from 7,500 to 8,000 steel tubes per month and the number of defective welds is practically nil.

THE CHAIRMAN: Mr. Forsyth, would you like to add anything to your previous remarks, in closing this discussion?

MR. FORSYTH: No, I think not. The principal object was to find out from those who are using steel tubes what difference they found in them, what difference in the tests should be made, what specifications should be made for them. There seems to be very few railroad men here who are using steel tubes, so we cannot get that information.

PROF. GOSS: I would like to venture the suggestion that in the

working out of the specifications so far as mechanical tests are concerned no distinction should be made between iron and steel tubes.

MR. WICKHORST: It is very easy to get almost any kind of steel tube to stand this test for an iron tube.

PROF. GOSS: That may be so. All that a mechanical test can do is to disclose the physical characteristics of the material. If a steel tube withstands a test prescribed for an iron tube, it is as good, so far as can be determined by the test in question, as the iron tube. If it isn't good enough, or if it can easily be made to withstand a more severe test, then the requirements should be raised, but the new requirements should then apply to the iron tubes as well as to those of steel. All this, of course, applies to mechanical tests alone.

MR. FARMER: I would like to ask the members here if it is the practice to test tubes after the safe ends are welded on before they are put in the boiler? We have always been accustomed to making the weld and putting them in and testing them afterwards.

MR. VAN ALSTYNE: Our practice is to weld the tubes without scarfing, and test them after they are put into the boiler, and if any of them leak, take them out. We have such a small percentage to take out that it pays to do it that way.

MR. BOURNE: I think the practice of testing flues after being welded depends to a certain extent on local conditions, that is, the care and attention that is given the work when the welding is being done. I know quite a number of roads that follow the practice as stated by Mr. Van Alstyne and think that with good care on the part of the welder, who must watch the fire and tubes closely, flue welding can be done and the number of defective welds be so small that it is not necessary to test them. I know a great many roads that are not testing flues and the number of flues they have to take out after the boiler has been tested is very small indeed.

THE CHAIRMAN: If there is no further discussion, a motion to adjourn is in order.

Adjourned.

OFFICIAL PROCEEDINGS

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The regular monthly meeting of the Western Railway Club was Held on Tuesday, November 17, 1903, at the Auditorium Hotel at 2:30 p. m., Vice-President J. A. Carney in the chair.

Among those present the following registered:

Arp, W. C.
Ault, C. B.
Ball, H. F.
Barnum, M. K.
Bell, J. M.
Bischoff, G. A.
Brandt, F. W.
Brazier, F. O.
Britenstein, J. F.
Brooke, Geo. D.
Brooks, P. R.
Brown, R. L.
Bryant, G. H.
Bryant, W. E.
Carney, J. A.
Collier, F. P.
Cooke, W. J.
Cota, A. J.
Cross, G. W.
Cushing, G. W.
DeRemer, W. L.
Doebler, C. H.
Ducas, C.
Farmer, C. C.
Farmer, G. W.
Fenn, Frank D.
Fergusson, H. A.
Forsyth, A.
Forsyth, Wm.
Goehrs, W. H.
Haig, M. H.
Harris, E. K.
Hill, Jas. W.
Hinson, J. A.
Hogue, O. D.
Howard, G. E.
Humphrey, A. L.
Keeler, Sanford
Kenney, Chas.
Kipp, A. R.
Larue, H.
Lape, C. F.
Maher, P.
McAlpine, A. R.
McCarthy, J. J.
McLeisch, W. J.
Mellon, W. P.
Midgley, S. W.
Mills, G. F.
Nelson, G. L.
Nichols, G. P.
Pfiager, H. M.
Pierce, Chas. F.
Raidler, W. P.
Roach, J. B.
Royal, Geo.
Rogers, M. J.
Senger, J. W.
Setchel, J. H.
Shields, H. S.
Shultz, F. K.
Silk, E. E.
Slater, F.
Smith, E. M.
Smith, Geo. W.
Stark, F. H.
Stimson, O. M.
Stocks, W. H.
Symington, E. H.
Talmage, J. G.
Taylor, J. W.
Thurmauer, Gustav
Toothe, E. S.
Waggoner, W. B.
Whitney, Geo.
Wilson, Geo. L.
Woods, Edwin L.
Young, C. B.

THE CHAIRMAN: I request, as there are only a few here this afternoon, that you take the front seats as much as possible. It is not often that the room is as cool as it is this afternoon, and I think it will be perfectly permissible to keep your overcoats on, and also your hats, if you care to.

The first order of business will be the approval of minutes of the last meeting as printed. Are there any corrections? If not, they will stand approved.

The Secretary then read the following report on membership:

Membership, October, 1903	1,060
Resigned	1
	1,059
New Members	13
Total	1,072

NEW MEMBERS APPROVED BY BOARD OF DIRECTORS:

NAME. OCCUPATION AND ADDRESS.	PROPOSED BY
Geo. D. Morrison, Peerless Rubber Mfg. Co., Chicago	Thos. Jackson.
Chas. S. Burt, Prest., Tweeddale Water Softening Co., Chicago	L. B. Sherman.
J. B. McLeod, Specl. Apprentice, C., B. & Q Ry., Brookfield, Mo.	J. S. Goddard.
J. H. Fredenhall, R. F. E., C. & N. W. Ry., Antigo, Wis.	J. F. Fleischer.
R. Whittier, G. F., C. & N. W. Ry., Kaukauna, Wis.	J. F. Fleischer.
Geo. L. Nelson, Rogers Metal Works, Chicago	M. J. Rogers.
E. C. Washburn, Washburn Company, Minneapolis, Minn.	J. W. Taylor.
Jay G. Robinson, Railway Supplies, Chicago	J. W. Taylor.
Elmo Owen, G. F., Chicago Union Trans. Ry., Chicago	Geo. Royal.
A. G. Delaney, C., B. & Q. Ry., Chicago	C. S. Bricker.
R. K. Pierce, Spec. App., C., B. & Q. Ry., W. Burlington, Ia.	J. A. Carney.
J. F. DeVoy, M. E., C., M. & St. P. Ry., W. Milwaukee, Wis.	A. E. Manchester.
E. M. Smith, Railway Appliances Co., Chicago	E. H. Symington.
J. E. Hall, Galena-Signal Oil Co., Chicago	G. W. Cushing.

THE CHAIRMAN: The next order of business is the reading of papers. The first paper on the list is entitled "Staybolts," by Mr. H. A. Fergusson.

STAYBOLTS.

By Mr. H. A. Fergusson.

There are few men connected with the mechanical departments of our railways who have not given more or less thought to the question of staybolts, and in many cases opinions have been formed which are based on the experience derived from local conditions, rather than from a general study of the subject, and the object of this paper will be to present on general lines some of the most frequent causes of staybolt failures, and also to indicate the most rational means for correcting or minimizing the trouble.

We all know that the greatest cause of broken staybolts is expansion and contraction of the firebox sheets, and it therefore follows that firebox design has a direct relation to staybolt breakage, and this fact, while so true as to be trite, is generally entirely ignored in designing new boilers. We scheme for larger grate area and increased heating suface; squabble over flue spacing and circulation, and then, when these and other elements satisfy us, stick in the staybolts at so many per square foot.

Does any one deny that the long narrow fireboxes, curving sharply outward to a broad crown sheet were designed with little or no regard for effect on staybolts? Or that staybolts screwed into a comparatively thin sheet at an angle of say 75 degrees will not soon prove troublesome? It is pleasing to know that our latest wide fireboxes eliminate all sharp curves in the side sheets, and consequently benefit the staybolts.

Since the relative difference in expansive movement between the outer and inner firebox sheets remains constant no matter what the space in the leg of the firebox, it follows that the wider apart the two sheets are, the less bending angle will be given the bolt, and consequently the greater number of vibrations may be had before breaking. I have seen this demonstrated most conclusively in some boilers having a seven inch water space at the crown sheet line, and but four inches at the mud ring, practically no broken bolts occurring above the horizontal central line of the box.

Staybolts break more frequently in bad water districts than in those districts where the water is freer from incrustating solids. This is not to be attributed to the action of the water on the bolts, but to the fact that such engines are washed out very much more frequently, with consequent vibration of the bolts each time. There is apparently no remedy for this, where water purifying stations are absent, except a flexible staybolt, and while numbers of these have been designed and tried, there are none of them that will not soon become inflexible through the hard scale formations around the movable parts. The best bolt therefore is one which has the greatest flexibility, and which cannot be affected by scale. Obviously this must be a solid bolt of

such material that it possesses requisite tensile strength, combined with the greatest vibratory strength. Copper undoubtedly possesses this combination of qualities to a greater degree than any other metal, and it is the prevalent custom in European countries to use copper staybolts. To us, however, copper is seldom considered, on account of expense.

One of the chief reasons for the superiority of copper staybolts is on account of the fibrous nature of the metal, and the more fibrous we can get a metal having the requisite tensile strength the more vibrations it will stand, and be consequently longer lived. The actual tensile strain on staybolts is far below their elastic limit, and if a bolt is not cracked it is improbable that it will ever break from boiler pressure alone, at the same time this pressure has a great influence on the failure of staybolts, on account of the vibratory strength (to coin a new expression) being very much weakened when the vibrations take place while the bolt is under tensile strain. This point was very clearly demonstrated in tests made by Mr. Francis J. Cole, and incorporated in his paper before the American Society of Mechinical Engineers in June, 1898, and extensive tests since have established the fact beyond question. The greater the strain per square inch then the fewer vibrations the bolt will stand, and as a bolt of small area will have a greater strain per square inch I would recommend an area which will not give more than one-tenth ultimate strength.

Reducing the diameter of the bolt between the sheets, will, within certain limits prolong its life, the best practice being to have the turned area slightly less than the area at the root of the threads, and leaving as generous a fillet as possible. The detection of broken staybolts is so important that no precautions should be too troublesome. The old and still used hammer test is more than unreliable, although some of our largest railroads depend entirely on this means of detection. I once conducted a test of staybolt inspectors. Seven condemned boilers were used, having no drilled bolts, and each inspector went over the bolts, sounding them and marking on a prepared diagram the bolts he considered to be broken. Four of the boilers were under a steam pressure of 50 pounds and the other three were cold. Afterwards the boilers were cut open and the actual conditions noted. Of 29 inspectors not one got all of the broken bolts in any one boiler, and no one got anywhere near the correct number of cracked bolts. Some of these men marked dozens of good bolts as "broken" and passed as many broken bolts for "good." This was the most powerful argument I ever knew against this method of inspection.

The bolt with a hole entirely through is bad on account of its weakening effect, the bolts starting to crack both from inside and out when vibrated, or exactly the same effect as when bending an ordinary piece of pipe. Of course as staybolts always break next to the outer sheet, any hole will be injurious, but by drilling a very small hole, say not over ⅛ inch, just through the outer sheet, a break will be detected

and the bolt injured very little by the hole, especially if a long fibre piled iron be used. A ten minutes inspection at the end of a run will disclose any bolts which may have been plugged on account of breaking on the road, and such bolts should be renewed at once.

The fact that the all hollow bolt cannot be plugged while on the road is to my mind an objection to it.

On account of its very short fibres, no bloom iron can possibly stand the vibrations that a piled iron will, as the latter is made up of long slim rods rolled and welded into a tough solid bar, and more nearly approaches copper in its fibrous structure. Some roads still adhere to imported bloom irons, although tests prove them far inferior to our best American piled irons when it comes to vibrations. But these roads, like the country producing the iron, do so because they always have, and are willing to pay for it.

There are only a few of our large roads which have standard specifications for staybolt iron, and with one or two exceptions these do not include any test for vibrations. I think it true that most of the roads depend entirely on results of road tests, and rather sneer at laboratory tests as not fulfilling road conditions, and therefore valueless. Laboratory tests of staybolt iron have value, however, if for no other reason than that they give comparative results, and it is safe to assume that if we test two irons in a manner as nearly conforming to actual service as possible, the one giving the best test results will last the longest in the firebox.

A machine for testing staybolts for vibration while under tensile strain is so easily contrived, that no road need be without one. Simply take an old slotting machine, and arrange a connecting arm to the tool head which will connect with a special chuck on the work-table. This special chuck is made with a stout body to be bolted to the table, and has a clamp for firmly holding the staybolt test piece. Another clamp, having a jaw to receive the connecting rod is fastened on the opposite end of the test piece, and a coil spring inserted between the two clamps with a compression nut, gives any required tension on the test piece. The stroke of the slotter is regulated to suit the vibration wished for (usually ⅛ inch each side of the center line on a radius of 5 inches) and a revolution counter will automatically count the number of double vibrations.

A slotter fixed up somewhat in this way has been in successful use in the test department at Altoona for several years, and the same arrangements could be applied to a shaping machine, so that staybolt iron could be tested in the machine shop or tool room, quite as readily as in a laboratory, and we may rest assured that any iron standing say 3,000 double vibrations under a tensile strain of 2,500 pounds will meet all other requirements as to tensile strength and elongation, besides giving the more practicable value of long life in the locomotive.

THE CHAIRMAN: Gentlemen, you have heard Mr. Fergusson's paper, which is now open for discussion. Mr. Forsyth, will you open the discussion on this paper?

MR. WILLIAM FORSYTH (Railway Age): Mr. Chairman, there are two or three points in the paper that I am rather interested in, and the one particularly relating to copper staybolts, because I found a report of some valuable experiments on copper staybolts, which I thought could apply to iron staybolts also, and I made some notes in regard to that which I will give you.

The most elaborate investigation of the strength of staybolts which I have ever seen is the one by Mr. F. W. Webb, formerly of the London & Northwestern road, communicated to the Institution of Civil Engineers and will be found in the Bulletin of the International Railway Congress of August, 1903. The copper staybolts are 1 1-6 in. in diameter and are used for boilers carrying a pressure of 200 pounds per square inch. It it found that on modern engines the number of copper staybolts replaced equals one for every 844 miles made. The bolts are not replaced on account of breakage, but on account of the heads melting off and leakage. Quite a number of alloys of copper with zinc, tin, aluminum and arsenic have been made, but none are any more satisfactory than copper. Under high pressure the strength of the staybolt is an important matter and the failure of the copper staybolts is due to the reduction in strength at high temperature. An interesting experiment was made in this direction by Mr. Webb in which he inserted a thermopile thermometer through a hole in the staybolt reaching to within one-half inch of the fire side of the sheet, and he found that copper bolts of the locomotive firebox may attain a temperature of 750 degrees Fahr. The staybolts were then tested under temperatures up to 750 degrees Fahr., and it was found that copper had the following strength and elongation:

Temperature Degs.	Ultimate Strength Tons.	Elongation in Inches Per cent.
60	14	62
400	10.8	54
600	$8\frac{1}{2}$	36
700	7.4	13
750	$6\frac{1}{2}$	14

Showing that the copper staybolt when at a temperature which it attains in the firebox had only one-half the strength of this normal temperature.

Compare with this the steel staybolt:

Degs.	Tons.	Per Cent.
60	26.8	40
600	33	26
600	30	34
700	26.7	32
750	26.5	32

Showing that the iron staybolt at this high temperature had a higher strength than a copper staybolt at the normal temperature.

It will be noticed that the strength of steel increased up to 600 degrees Fahr., and then steadily decreased. At 750 degrees the strength is equal to the highest strength of copper or any of the alloys used for staybolts at normal temperature. Under the severe work of American practice, it is quite likely that staybolts attain a temperature of 900 or 1,000 degrees Fahr., and the strength of the iron at such temperature is not more than 40 per cent of that at normal temperature.

This all suggested to me the thought that the temperature of the staybolt may have something to do with the failure of the iron, and that the staybolt may get hotter than we have ever imagined before, and especially when there is a coating of scale on it. Now, it may be said that staybolts never break on the firebox end of the boiler, and that is true, but with the large amount of scale on the staybolt, I can imagine that the heat is rapidly communicated through the staybolt and may have a high temperature at the outside end. This experiment which Mr. Webb made by drilling a hole clear through the staybolt within half an inch of the fire side and actually measuring the temperature there, is one that I never heard of before, and I have been wishing that somebody in this country would experiment on that line to find out what temperature we have in the firebox sheet and also the temperature of the staybolt.

The author speaks about flexible staybolts as not being a success on account of the scale forming and making them virtually rigid. That same statement was made in a couple of reports that were read before the boilermakers when they had a convention here, and I was rather surprised to hear it then, and I must say that I am now, because flexible staybolts are used very largely by many of the best roads, and they must have found them to be of some advantage, or else they would not continue to use them so extensively, and I should think that the slight amount of scale that does form would be easily worked off by the motion of the bolt and that would not be an objection to it. I think you will find that more flexible staybolts were used in the last six months than ever before; they are really coming into more general use.

In regard to the strength of staybolt iron and the method of testing it, I have thought that there must be some relation between the tensile strength and elongation and the vibratory strength, or vibratory quality and when the best staybolt iron is found by vibratory test, if we found its tensile strength and elongation, that we ought to be guided by the tensile strength only in finding a good staybolt iron. You could easily exclude the iron made from blooms, if necessary, by the etching test.

M. K. BARNUM (C., R. I. & P. R. R.): Mr. Chairman, I have had some experience with various types of staybolts and my experience with those so-called flexible staybolts which rely on a bushing in the outside sheet, and have the staybolts screwed into them, have not proven what they are claimed to be in the matter of reducing failures. On one road with which I was connected, we tried the practice of applying this class of flexible staybolts to the forward and back upper corners of the

side sheets where we found the most broken staybolts occurred in ordinary practice, and after trying them for two or three years, the advantages were found so few that we went back to the ordinary type of straight staybolt. We afterwards made a test of some flexible staybolts with a ball joint in a bushing, screwed into the outside sheet, and having a cap or plug screwed into the bushing through which the staybolts were applied, but the results I am unable to give. From the experience we have had with this class of flexible staybolts, and also with reducing the diameter of staybolts between sheets, I think that a staybolt, in order to be successful in resisting breakage, must be actually flexible and susceptible of movement in the outside sheet, or bushing if bushing is used, in order to have any positive advantage over the old type of straight staybolt. With the staybolts turned down between the inside and outside sheets, we found that they continued to break next the outside up to a point where they were made so small in the center that the fracture was transferred to the weaker point; i. e., at the smallest diameter. This was dangerous because with the safety holes used for detecting broken staybolts, we could not determine a broken bolt of this character, and they were abandoned.

My experience with broken staybolts has been that at least four-fifths of the broken bolts in the ordinary type of narrow firebox occur in the upper corners of the side sheets, about equally distributed between the front and the back upper corners, and that the balance are in scattered locations in the side sheets, but more especially near the front and the back edge of the side sheets. My experience has not agreed exactly with that mentioned by Mr. Fergusson, where he says that most of the staybolts broke at the narrow part of the water space, or toward the bottom of the firebox.

MR. A. L. HUMPHREY (Westinghouse Air Brake Co.): I do not like to discuss a paper that I have not read, and unfortunately I arrived too late to hear it read. However, the staybolt question is something that I have had considerable experience with, and about the time I gave up railroading I came to the conclusion that what I did not know about staybolts would fill a great deal larger book than what I did know about them. My experience with staybolts has been that they are very contrary. You can figure out on one boiler what causes the trouble which produces the breakages, and remedy what you think is the cause; on another boiler of similar construction you will find results directly the reverse, so that in about ten to fifteen years' experience, in watching the staybolt question closely, I came to the conclusion that I knew little, if anything, about it.

The paper mentions the fact that the narrow water space caused more broken staybolts than the wide one. That was true, until we got what is known as the wide firebox. The greatest trouble I have had the last few years with broken bolts has been in the top portion of the box of the locomotive boiler constructed with the wide box, near the top where the bolts are the longest. I have had locomotives of the

modern type that have broken as high as 100 staybolts in one month. This would occur on a locomotive running in bad water sections. Another locomotive constructed on identically the same plan as the locomotive I have mentioned, but running in a good water district, would not have a single staybolt applied during that time. Does not that indicate that the action of the water on the hot sheets, and the heat that has been mentioned by Mr. Forsyth have more to do with it than the peculiar design of the staybolt? Now, understand me, I do not advocate any old kind of iron for the use of staybolts. I have experimented with them, and I found that the very best of iron is not any too good for staybolts. I believe in the proper tensile strength, in the elongation test and vibratory test; these procure iron that will stand these requirements as near as possible; apply your bolts at right angles as near as possible with the sheets, turn them down between the sheets to the bottom of the thread. I believe this is about all you can do, unless you apply the flexible bolts.

MR. G. W. FARMER (A., T. & S. F. Ry.): I would like to ask Mr. Fergusson if he can give us the result of those twenty-nine inspectors' tests, that is, a table showing how many broken staybolts there were in each boiler and how many they found. Of course, the paper states in a general way, but it does not give the actual test results, which will be a little more in detail.

I agree with Mr. Barnum that most of the staybolts are found broken in the corners, that is, with the old firebox, and with the wide one also. In regard to the elongation, and the temperature of the iron at 500, 600 and 700 degrees, as mentioned by Mr. Forsyth, I would ask if there were any tests made to show the elongation as well as the strength at those different temperatures? The getting of the temperature of the whole staybolt made me think of a test made some years ago that was really about on the same plan, but was, to showing the circulation of the water, by drilling a hole through the outside sheet and putting in a hollow brass plug and inserting the thermometer in that plug, immersed in an oil bath. That brought it to my mind again.

MR. F. SLATER (C. & N. W. Ry.): I do not think that I can add anything to the staybolt question. It is something that we have all had a great deal of experience in, and perhaps do not know as much about as we ought to. I agree with all that is said about staybolts breaking in corners more readily than anywhere else, and that is due, in my opinion, to the greater expansion at that point. The road I am connected with has very little trouble with staybolts. All our locomotives are drilled from the outside, from a depth of an inch and a half to one inch and three quarters, and the staybolts are removed when found broken at any time. With the staybolts being examined and removed in that way, we have never had very many broken staybolts at any time. A regular inspection is made every thirty days.

I have heard some of the gentlemen present say that it was a good idea to turn the center of the bolt to the bottom of the thread. I fail to see that that is going to be of any benefit to the bolt whatever, for the

reason that the bolt breaks in the first thread from the outside sheet, at least that has always been my observation. I never knew a bolt to break anywhere only in the first thread at the sheet. Now, you can readily see that it is going to be very difficult to turn a bolt up as close as that to a sheet and have it to be of any value and therefore turning the bolt down in through the center is not going to prevent a bolt breaking at the thread, and the labor on the bolts in turning them down is thrown away.

I believe in using good iron, iron that is shown by test to be of the proper strength and one that will stand a great number of vibrations. But the nature of iron changes very rapidly after it is put into use in a boiler on account of the temperature changing continually, and an iron that will test very nice and soft and stand a great number of vibrations will not stand anywhere near that number when put into actual service.

THE CHAIRMAN: Gentlemen, this is a very interesting subject, and I do not think the discussion has been entirely covered. I do not like to start at one end of the row and go to the other, calling names, and if any one has any discussion to offer, we will be glad to receive it.

MR. HUMPHREY: In regard to the matter of turning down between sheets to the bottom of threads, it is a well-known fact that the modern engines carrying a pressure of 200 to 225 pounds of steam break a great many more staybolts than when they were carrying 150 to 180 pounds of pressure. I attribute that as much to the fact that the former engines had thinner sheets; the sheets being thin, they were a great deal more pliable than they are to-day with the heavy sheets necessary to carry the higher pressure. In order to overcome the rigidity of these heavy sheets, the staybolts should be properly screwed and riveted to the sheets, then by turning them down in the center, as referred to, it will give them needed elasticity. We know that it is not the strain on the staybolt that breaks it, it is the vibratory action, or the rigidity of the sheets, and the heating and cooling of the iron that does it. In my opinion we come very near getting back the action of the light sheets by reducing between the sheets to the bottom of the threads as I described. That is why I advocate it.

MR. FORSYTH: I think we would like to hear from the chairman on this subject.

THE CHAIRMAN: Our experience with flexible staybolts has been that they filled up with scale around the flexible head, which rendered the flexibility inoperative and that they broke just the same as the threaded staybolt, and we have done away with putting in flexible staybolts of any description. If it were possible to keep the lime incrustations away from the flexible head, I have no doubt that it would be a very good thing, but up to the present time they have not proven a bit better than the common screwed in staybolts.

The straight, solid bolt generally breaks at the outside sheet. The statement has been made this afternoon that they always break at the outside sheet. I have had one or two cases called to my attention

where they broke next to the firebox sheet; this occurred in the throat sheet. I do not know what particular action caused the breakage on the inside sheet, but it is so very infrequent that it can cause no alarm.

The reduction of the diameter of the body of the staybolt has proven beneficial because it makes the bolt slightly more flexible. I do not think any one would claim that it would do away with broken staybolts, but it is a fact that it prolongs the life of the staybolt. At one time we went into the matter very thoroughly, and kept some very accurate data on the subject, and found that in a firebox that had turned down staybolts on one side and the threaded staybolts on the other, that the turned down bolt did not break as frequently at first as the straight bolt, showing it had a longer life, but after a length of time the turned down bolt commenced to break about as frequently as the straight threaded bolt, showing that they are not absolutely free from breakage.

With reference to the reduction of the bolt, great care must be taken not to get the curve too deep, as that will weaken the bolt in the middle, and, if the bolt breaks in the middle, there is no means of knowing it is broken, so that the design should be made with the idea of having the bolt break, when it does break, at the outside sheet, where the telltale hole will give evidence of the broken bolt.

Mr. Fergusson speaks of bloom and piled iron, and I think that he is correct in his statement that piled iron of good quality will give better results in staybolt practice than bloom iron. In some tests that were made at one time we find that piled iron had about 75 per cent greater resistance to vibratory strain when vibrated at right angles to the line of the piling than when vibrated in the line of the pile. My explanation of that fact is that when the staybolt commences to break, due to the vibration, it breaks through the first pile and then has to start a fresh break in the second pile. The line of slag in between the two piles of iron makes an absolute check in the fracture, and the crack which starts through the first pile ends in that pile, and a fresh crack has to start in the second pile, whereas, with the vibrations in line with the pile, the crack starts and breaks straight through. We find that that is particularly true with steel. At one time steel staybolts were thought to be a solution of the staybolt problem, but those who tried steel staybolts soon found that they were practically worthless, and that was due to the fact that the crack which would start in the staybolt, due to vibration, broke through very much more rapidly than it broke through the iron, although it might have been a fact that for a single bend the steel gave great deal better results than the iron.

I would like to touch on the subject of leaky staybolts. We have found that one of the prolific causes of leaky staybolts in fireboxes is due to poor workmanship, and we have been able to do away with serious leakages of this sort by care to see that the threads on our staybolts numbered exactly twelve per inch and the taps cut exactly twelve threads per inch. By doing so we have a staybolt which fits

the threaded sheet, and there is no crowding one way or another. We have also found in practice that the use of tallow on staybolt taps is very satisfactory. It gives an excellent thread and does not make the muss that lard oil does.

MR. E. H. SYMINGTON (Railway Appliances Co.): I would like to make a few remarks in regard to testing staybolts. I recently had charge of some very interesting tests on the Lehigh Valley R. R. of several different kinds of staybolt iron. We rigged up a testing machine which we made out of the head stock of an old lathe placed on a rigid foundation. By putting an eccentric on the lathe spindle we obtained a vibratory arrangement very much as Mr. Fergusson describes. We tested about ten different kinds of iron, including several imported brands, and the first thing we did was to find out which brand of iron gave the best results. Then we started in to determine what effect the shape, etc., had on the bolt, also whether it was advisable to use an iron of smaller diameter and upset the ends, and we deduced from that part of the test the fact that we unquestionably would get better results by turning down the bolts at the center. We figured out eventually that although we got a more flexible bolt that would stand a greater number of vibrations, the benefit from doing that did not make up for the extra cost of the staybolt. The tests were as near working conditions as possible, and that was done by accurately screwing the staybolt into two pieces of sheet iron, representing the thickness of the firebox and outside sheets, and the spring that was put into the testing arrangement was calibrated to give a tension in the test specimen corresponding to 200 pounds boiler pressure, which we were using on the wide firebox engines that were giving us most trouble at the time of the test.

In regard to these tests, I would like to bring to the attention of the meeting the fact that a great many errors will creep in and unless the errors are reduced to a minimum the test is of little value. We found out that under exactly the same conditions, bolts that fit a little loosely in the sheet would vibrate a thousand times more than those that were very tight, and that explains, I believe, why the staybolts sometimes break at the inside sheet, which Mr. Carney said he had noted and we concluded that this was the result of their being much tighter in the inside than in the outside sheet.

The most interesting part to me of the whole test was a test of nickel steel bolts furnished by the Bethlehem Steel Company. We did not know what the analysis of the steel was when it was furnished; they simply sent down some staybolts to us and desired us to make a comparative test. We, however, ran a tension test, the piece breaking at about 125,000 lbs. and the interesting part of the test was that the number of vibrations it took to break the nickel steel bolts under the same conditions as to the bolts made of iron was about ten to one. The trouble with the nickel steel is that it is very difficult to run a die on the bolt to get the threads. We chased the threads on a lathe, and although they were not using nickel steel staybolts on that road for

many reasons, and on account of the expense and trouble in turning threads on them, nevertheless the results of the nickel steel test were so favorable as compared with the best iron bolts that it opens up an interesting point for discussion as to the use of a still higher grade of staybolt material.

MR. W. B. WAGGONER (Butler Drawbar Attachment Co.): This question is very interesting in regard to the two classes of material, bringing up the point as to whether the best material for staybolts has yet been found. We are all very familiar with tests under which staybolts are broken and as to the vibratory strain and tensile strain. The question seems to me has never been brought up or studied, at least in my experience, as to whether we have had the best material for staybolts. We certainly have used all sorts and kinds, and, as shown in Mr. Fergusson's paper, the ordinary tests of staybolts are practically worthless.

I know of an engine that was carrying 160 pounds pressure fitted with the ordinary firebox that was tested weekly for broken staybolts; when it came in for repairs, it had over 100 broken staybolts, much to the surprise of everybody, and we started out to see if anybody could tell where the broken staybolts were. The result was about as indicated by Mr. Fergusson's paper.

There certainly is a better material for staybolts than the ordinary best grade of iron that is ordinarily used, and the subject is certainly one that ought to be gone into, I think, by the test department to a sufficient extent to discover, if possible, what is the best material. It would pay, it seems to me, to put in better material, and even more costly material than is usually put in if it can be obtained. The question is whether some composition, possibly containing copper, would not bring around a better result, because it is an important thing and one which, with the ordinary inspection, it is almost impossible to discover, and with the high pressure that is being carried on locomotives these days, certainly the very best material that can be obtained on staybolts is one that is of paramount necessity.

MR. SLATER: I would like to ask the last speaker whether they are using the drilled staybolt. He said a certain engine had 100 broken staybolts, that looks to me to be rather a serious affair, and if the bolts were drilled, I do not see how they can have any broken staybolts without knowing it. We know whenever they are cracked at all, by a slight formation of lime around the opening.

MR. WAGGONER: No, these were not drilled staybolts, they were the ordinary kind.

MR. SYMINGTON: I would like to bring out another feature, and that is that we tested bolts under similar conditions that had drilled and also that had punched tell-tale holes. We found, although we could not account for it, that unless the punch annealed the iron somewhat, that the staybolts that were hot punched withstood a greater number of vibrations than those that were drilled. These tests extended over a period of two or three months and were very carefully made.

THE CHAIRMAN: Any further discussion on this paper? If not, Mr. Fergusson, will you close the paper?

MR. FERGUSSON: Mr. Forsyth spoke of the copper staybolt being weakened very much by heating and also about drilling and testing the temperature with thermometer, pointing out what the temperature was. I know nothing about such a test and have not seen the report that he spoke of, but it occurred to me that the heat would be absorbed by the water taking it off as rapidly as it was formed. I should think that would have a reactionary tendency that would overcome any dangerous temperature at the outer sheet.

Regarding flexible bolts and the scale causing them to be inflexible, what Mr. Carney said had been his experience, certainly has been mine also. I have examined a great many flexible bolts made with a bushing that had a ball joint and cap screw, and the scale would form between the cap and the bolt and make it as rigid as solid iron. One of the most practical and best flexible bolts that I know of was used by the Pennsylvania Railroad, and is to-day so used. It is a bolt that was designed by the foreman of the boiler shop at Altoona and is flexible simply because it gives greater length of bolt. I will not mention the bolt by name, but I have no doubt that all of you who are familiar with the subject know to which bolt I refer. It was simply a cap screwed into the outer sheet and the bolt was screwed into the cap and riveted there, and it gives about an inch to an inch and a half more length of bolt, and these bolts may last 100 per cent longer than the solid bolt. On account of the cap sticking out so far beyond the outer sheet, they are only practical on a small area of the box.

Mr. Barnum spoke about my stating that bolts break at the narrow part of the box instead of at the top, that being contrary to his experience. He misunderstands me. I say that a firebox which had practically the same width of water leg all the way up would have the bolts broken in the corners, but a firebox which is designed with the narrow part of the box at the mud ring and extending up to a wide waterspace at the top, would have very many less broken bolts at the upper corners than the box which has the water leg parallel.

Another gentleman spoke of noticing some bolts that broke at the top corners where it was much wider. I am unable to account for such a condition; it is something unusual.

Regarding Mr. Farmer's request in reference to the test that I have mentioned in the paper, that test was made by the Pennsylvania Railroad at their shops at Sunbury, on the Philadelphia and Erie Division, and the tests were incorporated in blueprint form and are in the files of the Pennsylvania Railroad. I have not kept copies and they are not for publication, so far as I know, therefore I cannot give you the exact figures, but the general results I remember very well indeed, and I have stated them in the paper. Possibly they will give you that information if you care to request it of them.

Most of the questions that have been brought up have been answered

by one or the other of the members who have spoken, and I have nothing further to say. I was very much interested in the description of the tests which Mr. Symington mentioned, and while it may be true, as I say, that laboratory tests do not demonstrate conclusively just what will happen on the road, I still am of the opinion that comparative laboratory tests will give comparatively the results which will be found on the road.

THE CHAIRMAN: Gentlemen, we have another paper before us this afternoon entitled "Train Pipe Leakage," by Mr. C. C. Farmer. The paper is as follows:

TRAIN PIPE LEAKAGE.

By C. C. Farmer.

While the causes for train pipe leakage and methods and means for preventing it have been quite thoroughly discussed by the various railroad clubs and associations, a visit to any railroad yard for the purpose of inspecting brakes in trains will, I believe, convince us that excessive leakage exists and that much of it would not exist if the piping had been properly erected and a little more attention given to it at regular intervals, i. e., when the brake is cleaned.

Contrary to what might appear to be the case a heavy leak from the train pipe on a car is frequently not as serious as a small one for the reason that it can be quickly located by the car or train men and will either be repaired or the car switched to the rear end of the train. While a small leak which alone will not waste any considerable quantity of air, is difficult to locate and when found is not considered bad enough to warrant the loss of time necessary to repair it or to switch the car to the rear, therefore, is given little or no attention. Following this from day to day we find such leaks increasing in number and eventually enough brakes containing them bunched in one train to render the maintenance of standard pressures difficult, if not impossible, at the same time unless conditions are very favorable but little leakage can be located. With the long trains now handled such conditions become quite serious. When we consider that a 9½-inch air pump requires 176 strokes per minute to maintain 90 lbs. main reservoir pressure against a leakage orifice 11-64 inch in diameter, the effect of numerous small leaks will readily be appreciated.

In view of the facts stated above and that train pipe leakage cannot be cut out and the defect carded to indicate that repairs must be made at a later date when the car is not in the train, except when the leakage occurs between the cut out cock and the triple valve, we can understand why what appears to be an unnecessary amount of time is used in getting trains ready to start from a terminal or as is too frequently the case, trains leave the terminal with train-pipes in such condition as to cause serious delay and sometimes expensive accidents while on the road.

Train-pipe leakage necessitates an increased speed of the air pump, which in time results in air pump failures, now classed as engine failures. Another very serious result, sometimes caused by train-pipe leakage, particularly when pumps are overheated, is to prevent the air remaining in the main reservoir long enough to cool to atmospheric temperature and drop its moisture, therefore, the water is precipitated in the train pipe where it freezes in cold weather.

Train-pipe leakage is frequently increased, especially in cold weather, by hose coupling leakage caused by the stretching of heavy trains.

If the train pipe is comparatively tight otherwise, this additional leakage will in the majority of cases, be supplied by the pump, but when the leakage is already taxing the pump's capacity, we can expect the air pressure to fall, apply some or all of the brakes, and stall the train. These conditions are most likely to occur when the engine is working hard and at slow speeds; therefore, sand is often required on the rail and the use of the air operated sander will add to the consumption of air and further increase the liability to the troubles above mentioned. This is especially true if the engine is equipped with a D-8 or other engineer's brake valve using an excess pressure valve to feed the train line. The stalling of trains always causes expensive delays and is frequently followed by damage to draft rigging when an effort is made to again start the train.

Heavy train-pipe leakage, coupled with the loss of excess pressure, increases the difficulties and dangers of handling trains on heavy descending grades, and also the liability to break trains in two when releasing brakes on long trains, the serious results of which are too well known to require discussion at this time.

Leakage through porous air hose is the most difficult of any to locate as car and train men usually detect leakage by sound and no other leak in the brake system can discharge as much air with as little sound as this one, on account of the discharge being distributed over such a large surface. The effect of air hose leakage of a given volume is much more serious than from any other point in the train pipe for the reason that moisture is carried into the duck causing it to rot and eventually the hose to burst, resulting in serious delay and often serious damage to cars and lading.

The causes for train-pipe leakage are many, but are generally of such a nature that they can be easily eliminated, and if we can by a little care, and perhaps a small increase in first cost, so assemble and attach the piping to cars that, say only 25 per cent of the leaks now found in trains will be prevented, and the majority of such leaks as will occur from time to time restricted to points where they can be quickly and easily located and stopped by car or train men, we can say, without endeavoring to show the exact saving in dollars and cents, that a good investment has been made; also, that if we provide means for pipe testing and repairing at all points where brakes are erected or cleaned and insist upon this work being done in a proper manner, we will further reduce the number of leaks that must be either stopped after a train is made up, or be supplied by the air pump.

Experience has proven conclusively that where care has been exercised and work on the piping of the brakes has been properly performed and up to standard, and that the proper system of inspection has been enforced, delays to trains in the yards and on the road are very materially reduced and the expense of such work increased very little, if any.

Many brake cylinders and auxiliary reservoirs are attached to the

cars in such a manner as to permit the cylinder to move more or less each time the brake is applied. This is sometimes due to insufficient strength in the plate or straps on which the cylinders are carried and often by the cylinder block being so attached to the car sills, or the bolts holding the cylinder on the block so applied that they cannot be properly tightened after the blocks and sills shrink without first removing the cylinder and its block from the car body; therefore, the cars are very liable to, and do leave the repair tracks with the cylinders loose. When these conditions exist on cars fitted with the detached cylinder and reservoir, leakage in the pipe between the cylinder and reservoir, will be common, and with the combined cylinder and reservoir excessive triple valve union joint leakage will be found. Attaching the brake cylinder and auxiliary reservoir rigidly to the car and in such a manner that they can be quickly retightened on the repair track, if they become loose, will eliminate practically all of the leakage occasioned by the above mentioned defects.

Pipe union joints located back of hoppers or other inaccessible places, as is common in some types of cars, are fruitful sources of leakage that are impossible to locate under conditions usually existing in train yards, and when leakage is located is often difficult to stop, therefore, it is always advisable to locate train pipe unions in an accessible position even if it necessitates the use of an additional threaded pipe connection, which is often the case.

Pipe threaded with badly worn or otherwise imperfect pipe dies will usually leak unless the threads are well coated with lead or cement, neither of which can always be depended upon to produce or maintain a perfectly tight joint under these conditions. A safe rule to follow when fitting up piping is to require the use of dies that will produce threads perfect enough to make up a tight joint when coated with oil to prevent cutting. Lead or cement applied to such threads will be found beneficial.

Union joints, to remain tight under the severe conditions of road service, must go together without springing the pipes to any extent and with the gasket faces nearly parallel. Prepared leather gaskets should be used in all unions for the reason that they will yield sufficiently to produce a tight joint with reasonably true union faces, and yet when the union nut is properly tightened will prevent vibration in the joint, the result of which is to loosen the nut and cause leakage. A leather gasket will not blow out if the union is loosened by vibration, as is the case with rubber gaskets, therefore, leakage from a union fitted with them can always be quickly stopped by tightening the nut.

The location of angle cocks outside or back of the position fixed by the M. C. B. association, a not uncommon practice, is equivalent to shortening the air hose and increases the leakage between hose couplings when the hose tubes are frozen, also when the draw bars pull out farther than they should. Insufficient clearance between the angle cock

handles or keys and the dead wood permits the latter, when loose, to force the cock key from its seat and produce serious leakage, and in a short time ruin the fit of the key in the cock body. This trouble can be found on some cars in nearly any railroad yard and should be prevented by providing not less than 1¼-inch clearance between the end of the angle cock and the deadwood.

No matter how well the piping on a car has been put together if it is not securely clamped at enough points to prevent all vibration, and in such a manner that it cannot be shifted toward either end of the car by the heavy strains it is sometimes subjected to in service, leakage will occur frequently in the union joints. In this connection we can say that only a comparatively small percentage of the train pipes on cars are attached to the car sills with a sufficient number of clamps to prevent vibration, also, that the construction of many of the clamps is such that they do not hold the pipe solid.

Leakage from between air hose couplings and through hose tubes is frequently caused by train men or others pounding down the hose coupling guard arm to stop the leakage that results from worn or damaged coupling packing rings. Hose couplings in this condition cannot be coupled properly or uncoupled easily by hand, and require considerable force to pull them apart, a too common practice, which results in such heavy strains on the air hose that if it does not tear the hose off, usually damages it in such a manner that it will soon commence to leak or burst. Hose couplings in the condition stated are frequently fitted in new hose tubes and returned to service, a bad and expensive practice that should be stopped.

Pulling air hose couplings apart instead of separating them by hand is the direct cause of more train-pipe leakage than any practice followed by trainmen, for it strains and therefore weakens the hose near its upper end, the point where most hose failures occur, and also shifts train pipes from their correct position. If it were possible to completely stop the bending down of coupling guard arms and get all damaged couplings now in service repaired or discarded, the practice of pulling air hose apart would not be followed by such serious results, except when the couplings and gaskets are frozen, but as this is practically impossible the next best thing to do is to require air hose to be parted by hand and the only satisfactory method known to the writer for accomplishing it is to have the work done by car inspectors. Against this it may be said that more car men will be required to do the work in busy yards, but the employment of a few car men is only a question of dollars and cents to the railroad company. So also is the practice of pulling hose couplings apart, for some of the results of this practice, such as burst air hose in long air braked trains, are, as you know, very costly. To this latter item of expense may be added some of the delays to trains and interference with train handling resulting from excessive train-pipe leakage, also a percentage of the new hose purchased and the maintenance of train pipes. An examination

of a few hose couplings on cars in trains, will, I am quite sure, convince you that many coupling guard arms are bent down and I doubt if you will have much trouble in finding some so badly bent that they cannot be pulled apart by hand even with the coupling packing rings removed, in which condition they should fall apart.

Another common cause for leakage between hose couplings is the practice of trimming the flange of the hose coupling packing rings to permit them to pass freely into the coupling grooves without cleaning the latter. This ruins the fit of the packing ring and permits air to pass around the flange, therefore, the practice should be stopped. If the men applying coupling packing rings are furnished with, and required to use a suitable tool for cleaning the coupling grooves, coupling packing rings can be easily inserted without trimming or otherwise changing their form.

When air hose are not properly coupled together, as sometimes occurs, the gaskets are forced out of shape. Occasionally they will return to their original form when the couplings are parted, but in cold weather they are very liable to retain the form in which they were forced by improper coupling. If the car is equipped with the modern dummy coupling, and the hose is attached to it when uncoupled, the boss on the face of the dummy coupling will restore the gasket to its correct shape, thereby very materially reducing the liability to leakage when again coupled with a hose coupling. The benefits derived from the dummy coupling as stated, are alone sufficient to warrant the railroads that have done away with them in again applying them to all cars.

A failure to locate and stop all leakage on new cars and cars that are on shop tracks for cleaning, causes unnecessary trouble on the road and expensive repairs in yards. All leakage should be located by charging the brakes to standard pressure and painting the joints and air hose tubes with soap suds, and when any leakage is found in the joints, repairs should be made, and if in the hose tube the defective hose should be removed and the tube destroyed by the man that removes it, to prevent the hose being returned to service.

Putting in vogue on an important eastern road the system of inspection and workmanship suggested in the foregoing, resulted in reducing the number of burst air hose at least 90 per cent; also delays on account of failure to air pumps and repairs to same, and the number of draw heads pulled out and broken, the latter of which is one of the most vexatious problems that railroads have to contend with.

THE CHAIRMAN: Gentlemen, you have heard Mr. Farmer's paper. We regret that we were unable to distribute this among the members of the Club before and are compelled to distribute it here at the meeting. Owing to the fact that another paper which we had anticipated presenting to-day failed to reach us, this paper was prepared on rather short

notice. You have all heard the reading of the paper, a very interesting one, and a subject that I think all of us who are railroad men have had more or less experience with, that is, leakage in air brake parts. Mr. Cota, will you open the discussion on this paper?

MR. A. J. COTA (C., B. & Q. R. R.): This paper presents a great many important points; some of them have been thoroughly discussed, but it appears that one of the important points to be observed is the fitting up of an air brake car properly when the car is first built. The start should be made with the piping; all threads should be cut clear so that air-tight joints can be easily made. The brake should be thoroughly examined by a competent car inspector, or some one whose duty it will be to test for leaks.; The piping should be thoroughly clamped to stop all vibration, and if that is done very many of the train pipe leakages we now find will be done away with.

Mr. Farmer has brought up a point here about leakage through the air hose. We find that this is one of the most troublesome points that we have to contend with, and from the very reason that the writer has suggested. The leak is not easily detected, and in many of the yards throughout the country it is the custom now to test the hose by throwing water on the same after the pressure is pumped up.

The writer refers to the location of the angle cocks, and of their being in a position outside or back of the point fixed by the Master Car Builders' Association. We are not having as much trouble now from the wrong location of the angle cocks as we did some time ago, but I believe this is due to more thorough inspection and a more thorough understanding of our air brake men as to what is required. We have found a great many leakages caused by the trimming of the flange of the packing ring or coupling hasket. I believe that this point has been thoroughly discussed and our repair men now understand that if the groove is thoroughly cleaned the ring can be placed in position without trimming.

There is mention made here of the uncoupling of hose by hand. We all know that a great many of the yard men in switching cars simply close the angle cocks and switch the cars out, but in one yard that I visited a few days ago I found that it was the practice that whenever the engine foreman got the bills for his train—his switching list—that one man was sent out to uncouple all hose by hand, and the report was made that the results were highly beneficial. It seems to me that a good point is to instruct all car inspectors thoroughly in regard to what trouble a leak will cause an engineer in handling an air brake train. I believe that most of the air brake inspectors are now making a specialty of that part of the work, and if all car inspectors understood thoroughly that the slight leaks in the train pipe will do exactly what the engineer does when he wishes to stop, they will be more careful. We find that occasionally trains are broken in two as the result of leaks in the train pipe. That is brought about, it appears, by the engineer following out his instructions and reducing from five to eight pounds of train pipe pressure as the initial reduction, and the leaks in the train pipe then still further

reducing the train pipe pressure, setting the brakes harder and causing the engineer to release the brakes before he gets to the point, or water tank, or coal chute where he wishes to stop. He releases the brakes while the train is in motion, and we all know what the results have been.

Another bad feature about train pipe leakage is that, particularly on short trains, we have brakes applying emergency when the engineer says he has made but a service reduction of train pipe pressure. I believe that if our car inspectors were more thoroughly instructed we would get far better results in handling brakes on the road.

MR. C. H. DOEBLER (Wabash R. R.): I am fortunate in not having the care of cars, but have the care of locomotive equipment only. We know of the trouble of train line breakage, its effect on the air pump; we also know the complaints that are made of the engineer from using emergency applications when he claims that he has only made the service stop. I think that this whole matter can be summed up under three points—careful inspection of material, careful workmanship and careful inspection by the car inspectors and others in looking after the equipment.

MR. J. B. ROACH (C., B. & Q. Ry.): There is one point that I hear considerable complaint on in different parts of our system that Mr. Farmer has not touched on in regard to train pipe leakage, and that is the location of train pipe on the cars and on engine tenders. In going through different shops I have noticed that several different times, especially on engine tanks. The Master Car Builders' Association, I understand, requires the train pipe location thirteen inches from the center of drawbar to the center of train line, and in many cases I have found the train pipe located all the way from thirteen to twenty-two inches from the center of drawbar, which is equivalent of course to a too short main connection, and in a good many cases apply the brakes, while snow or frost or other drawbacks causing the drawbar pull to be a little bit stronger than usual, the distance of the train pipes to the hose is sufficient to apply the brakes, and in a great many cases you will find more or less leakage on account of the hose being stretched. I think that is a point that should be looked after in the shop and repair yards, to see that the train pipe is located according to the M. C. B. standard. In that way I think it will eliminate a great many of the train pipe leakages.

MR. BARNUM: I recall one very interesting case which illustrates the importance of locating the angle cock properly. On the road with which I was recently connected, we had a case where the engineer started down a long grade averaging from twenty to thirty-five feet per mile, with a train of about forty cars, and after he had gone several miles he had occasion to stop and take a side track to meet another train, which fortunately was not yet in sight. and he ran by the switch about a mile. The train men looked along the train to see what the trouble was, and found an angle cock in one of the cars partly shut off. They turned it in the proper position to let the air pass through the

train pipe and backed up to the side track, and after the other train had passed the engineer pulled out and ran along to a point where he was to get orders, and ran by about half a mile. He was looking out for trouble on account of his previous experience, and the trainmen again looked the train over and found the same angle cock partly shut off, but did not locate the cause of it. The next time the engineer had occasion to make a stop he found that he had only partial control of his air and ran by the proper stopping point the third time. He then went back to look the train over for himself, and found the angle cock on this particular car located so that the top of it struck the under edge of the deadwood. The plug in the angle cock body was quite loose, and the pipe was loose in the clamp, and the result of the continual vibration of this pipe and the pounding of the top of the plug against the deadwood gradually shut this valve off. The car was set at the rear of the train and he experienced no further trouble, fortunately having escaped a serious accident by reason of there being nothing in the way. We took this car to our repair tracks and found that by taking hold of the air hose and shaking the pipe in the manner that it would naturally vibrate when passing over the road, the cock would be regularly shut off within a very short time. This trouble was due solely to the improper location of the cock, and I have no doubt that other accidents which have been unexplained may have been caused in the same manner, but the men who were victims of the accidents were not fortunate enough to locate the exact part where the trouble had existed and have had to stand the consequences.

MR. H. F. BALL: Considerable has been said about the inspectors taking care of leaks in train line, but nothing has been said as to how they shall do it. On the Lake Shore we have seven division terminals, and these we are equipping with air testing plants. Aside from these we have about from fifty to seventy-five interchange or inspection points, where we receive anywhere from 10 to 100 cars a day, with no steam or air plants, and to provide air for testing the cars at these places would mean an enormous expenditure of money. Cars that are received at these interchange points have to be moved from 15 to 100 miles before they reach a testing point. What we ought to have is an inexpensive air compressing plant. At these small inspection points men are not fully employed and the amount of work that we could get from them in keeping up the air brake equipment would mean a good deal. If we endeavor to have this work done at main line division terminals only it will result in serious delays to movement of trains through the yards, and during periods of heavy traffic would no doubt block the yards. This is one of the problems which is being considered to-day.

MR. HUMPHREY: The remark that Mr. Ball has just made is very true. If the inspection is properly made, and the work is properly done on the air brake equipment at the time the triple valve receives attention, it is going to largely overcome the difficulties that have been referred to. I agree with Mr. Ball that all railroads should have air plants at these unimportant terminals. Some roads are at the present time installing compressors where they have no steam that are operated

by electricity. Others are using gasoline for this purpose so that tests can be made, but I believe the most important object of all is to have the inspection properly done and the work attended to at the time the triple valve and the cylinders receive attention.

My experience in the past with car men has been that they will give the triple valves attention every six or nine months, as the rules require, but pay no attention to the train pipes and let the leaks in the train pipes go on until they become so bad that the car must be set out in transit and the work done. That will be done at some of the outside points that Mr. Ball speaks of, where there is no air plant. The result is, there are no means of testing the work after the work has been completed. We generally have had inspectors at the outside points that were provided with old tools, a stock, and a die that has been worn out and discarded from the head shops and sent out for use at these outside points. The result is, when they do the work it is not properly done, the clamps are not properly secured; with them it is anything to get the car off their hands. Along comes the trainman or switchman, picks up the car and, throwing it into the train without testing, makes the car go regardless of results. A large majority of the cars are receiving this kind of attention, whereas if they were tested as outlined in the paper, at the time the work is done, and the work on the pipes and joints looked after, the gaskets renewed when necessary, the clamps properly attended to. I believe that the conditions would improve enough to justify the expenditure.

There is one mention made that has not attracted attention yet that I want to speak of, and that is the practice of uncoupling all cars at the terminals that have to be switched by the car men, not depending on the switchmen. Any mechanical man knows that the greatest difficulty with train pipe leakage is on account of the switchmen not uncoupling the hose. It is a common practice in our largest yards for the switchman to switch cars without pretending to uncouple the hose. It results in tearing the hose, in fracturing them so that they leak, pulling the train pipe through the clamps and causing an endless amount of trouble. While I was on the Chicago & Alton that question came up and they decided to try the uncoupling of the hose by the car men. Orders were issued that the switchmen would have nothing to do with the uncoupling of the hose. The result was that we actually reduced our car force that had been attending to the car repairing in the yards where switching had been done, and still the car men took care of all the couplings and uncoupled every car that had to be switched as it came in. They got the list as they came in from the yard master and the first thing they did was to uncouple the hose. I believe that if that practice would be put into effect throughout the country the number of bursted hose would be reduced very materially and that the couplings would be in the same proportion, to say nothing about the wear and tear on the pump and the other parts of the air apparatus.

MR. J. F. BREITENSTEIN (C., B. & Q. Ry.): I would like to ask a question, and that is, is there any one present who has had any experience in splicing air hose? As I understand, some of the roads are doing

it where the switchmen have been uncoupling without the hand. I would like to hear from some one in regard to that question.

THE CHAIRMAN: Has any one had any experience in regard to the question asked by Mr. Breitenstein in reference to splicing hose that has been pulled apart by a switchman? Is that correct?

MR. BREITENSTEIN: I understand some of the roads are using this same hose that has been discarded and splicing it in order to give it the same length, and the question is, whether it is a factor of economy to use this hose instead of the new hose, whether the hose is not weakened to a certain extent, and whether the connection in between there is not an obstruction.

Usually the hose that is spliced has seen hard service, not only by being pulled apart by the switchman. And I believe the splicing of hose is only in an experimental stage at present, and it is only a question of time that will determine their reliability under conditions of service, which are unusually severe on account of dirt, grease and oil and other combinations which it is impossible to exclude while in service.

The air in the train line should, in my opinion, have a free and uninterrupted passage, and I believe the time is not far distant when they will use larger train pipes in the passenger service, especially where the larger cylinders are used, such as the 12-inch, 14-inch and 16-inch cylinders instead of the 10-inch.

At some future time I would like to see this matter taken up for discussion.

MR. SLATER: I can say to the gentleman that there is a great deal of spliced hose used and we found it all right. Of course we never use hose for the purpose of splicing unless it is practically as good as new and has only been damaged by the switchmen failing to uncouple and the hose has been torn in the middle. Then we select hose of that kind and uncouple it and splice it and get very good results from it.

MR. G. W. FARMER: I wish to endorse Mr. Farmer's statement where he makes mention about the increased speed of the air pump, which does not give the air in the main reservoir sufficient time to become cool enough to precipitate the moisture, which is thereby carried back in the train, and as we all know in cleaning triple valves, there will be a large amount of rust found and a great deal of trouble caused by this steam moisture. I would also like to bring out the point as to how hard it is to get employes on the railroad to understand the necessity of marking all air hose when it is applied, and also when it is taken off, to determine the length of service which we obtain.

And the third point is the necessity, particularly with air hose which is coupled between the engine and the tank, that the pipe on the tank and the pipe on the engine shall be of the right length, so that the hose when coupled between shall neither rub on the brake beam nor on the safety chain.

MR. P. MAHER (I., I. & I. R. R.): I do not think it is necessary to say anything further on this question. There have been sufficient recommendations made already, if followed out, to give us satisfactory results. It resolves itself into the question of the superintendents of motive power

and master car builders following out the recommendations to eliminate the present trouble. We do not experience any of the trouble referred to on the I., I. & I.

THE CHAIRMAN: If there is no further discussion on the paper I will ask Mr. Farmer to bring the discussion to a close.

MR. FARMER: Mr. Chairman, I do not think it is necessary to add very much to what has been said. Before answering Mr. Breitenstein's question in regard to splicing hose, I will say that in testing air hose with soapsuds, on all cars passing through a terminal, that it was found necessary during the first month to remove nine per cent of all the hose tested, but the number found defective gradually diminished from day to day as the cars returned to the terminal until it reduced to a constant average of about one and one-half per cent. This practice almost wiped out the burst hose question on the road and it made every one happy by reducing the number of pulled-out drawbars; it also very materially reduced the time required to handle the trains over the division.

The common practice followed for some time of splicing air hose which we followed until we commenced to test the hose with soapsuds I consider an expensive one, for the reason that we discovered that the number that were found to be porous after they were fitted up was so great that instead of being an economy it resulted in additional expense, therefore the practice was entirely discontinued.

I am of the opinion that any hose that shows leakage through the surface is not in fit condition to be placed in service, no matter how small the leakage may be.

In answer to Mr. Ball's question about the method to be recommended, or that I might recommend, for locating the leakage on cars coming through interchange points, my experience has been that where the transportation department allowed the car department sufficient time to charge the brakes with locomotive or yard plant and correct such leakage as is necessary to put them in satisfactory condition before the train is started, the time consumed in moving the train over the division was reduced. On the eastern road previously referred to an hour was allowed for testing the brakes in the yards, after the trains were made up, and it actually resulted in saving more than that amount of time in moving trains over the road. The service conditions on that line were quite severe, and the car service such that accurate records could be obtained, therefore no difficulty was experienced in showing an actual saving.

THE CHAIRMAN: This finishes our business this afternoon, the discussion of the two papers. Is there any further business to be brought before the meeting? If not, a motion to adjourn is in order.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular monthly meeting of the Western Railway Club was held on Tuesday, December 15th, at the Auditorium Hotel, Chicago, Mr. J. A. Carney, vice-president, in the chair. The meeting was called to order at 2:30 p. m.

Among those present the following registered:

Bell, J. M.
Brazier, F. O.
Brandt, F. W.
Brooks, P. R.
Buell, H. C.
Baker, C. M.
Carney, J. A.
Collier, F. P.
Cooke, Allen.
Cory, C. H.
Crossman, W. D.
Cushing, G. W.
Deming, H. V.
DeRemer, W. L.
Doebler, C. H.
Dunham, W. E.
Fenn, F. D.
Fergusson, H. A.
Forsyth, Wm.
Frost, Harry W.
Fry, C. H., Jr.
Ettenger, C. D.
Gilpin, F. M.
Hall, J. E.
Harris, E. K.
Hechler, W. D.
Henry, C. S.
Hinson, J. A.
Hubbell, Ira C.
Isbester, G. C.
Jackson, E. J.
Jackson, Thos.
Johnson, W. O.
Keeler, S.
Kenyon, E. C.
Kucher, T. N.
Linn, H. R.
Ludlow, C. G.
McAlpine, A. R.
Midgley, S. W.
Nichols, G. P.
Nickson, R. F.
Otis, Spencer.
Otley, Benj. F.
Otto, O.
Parker, W. R.
Patterson, J. B.
Peirce, R. K.
Rowley, S. T.
Royal, Geo.
Seley, C. A.
Shults, F. K.
Silk, E. E.
Slater, Frank.
Symington, E. H.
Taylor, J. W.
Thompson, J. S.
Thurnauer, G.
Tratman, E. E. R.
Traver, W. H.
Van Wort, G. E.
Younglove, J. C.

THE CHAIRMAN: The first order of business will be the approval of minutes of the last meeting. They have been printed and distributed, and if there are no corrections, will stand approved as printed.

The next order of business is reading names of new members, which the Secretary will now do.

Membership, November	1,072
Dropped, mail returned	4
	1,068
New members approved by Board	10
Total	1,078

NAME.	OCCUPATION AND ADDRESS.	PROPOSED BY.
J. D. McGuire,	Christensen Engineering Co., New York	C. H. Doebler.
H. A. Brimley,	draughtsman, M. P. Dept., Penna. Co., Ft. Wayne	G. L. Wall.
A. F. Stetson,	Houghton & Richards, Chicago	F. G. Benjamin.
F. M. Sessions,	Forsyth Bros. Co., Chicago	G. H. Forsyth.
C. T. Boone,	Trav. Train Master, C. & N. W. Ry., Chicago	H. T. Bentley.
G. E. Van Wort,	Murphy Varnish Co., Chicago	C. D. Ettenger.
C. M. Baker,	Murphy Varnish Co., Chicago	C. D. Ettenger.
F. J. Riechmann,	V.-P. & G. M., Street's Western Stable Car Line, Chicago	C. M. Mileham.
E. A. Gilbert,	West. Repr. W. H. Miner Co., Chicago	J. W. Taylor.
J. G. McGee,	Hildreth Varnish Co., New York	C. H. Doebler.

THE CHAIRMAN: The next order of business will be the reading of papers. The first paper on the list is "Plan to Establish a Machine Rating in a Locomotive Machine Shop, With Special Reference to New Tools," by Mr. J. F. De Voy, M. E., Chicago, Milwaukee & St. Paul Ry.

The paper is as follows:

PLAN TO ESTABLISH A MACHINE RATING IN A LOCOMOTIVE MACHINE SHOP, WITH SPECIAL REFERENCE TO NEW TOOLS.

By Mr. J. F. De Voy, M. E., C. M. & St. P. Ry.

The object of this paper is to establish by a system of cards 6 inches long by 4 inches wide information relative to the number of cuts, length of time and general movement of work to be performed. The introduction of new machine tools and of new tool steel has increased the output of new work to such an extent that many of us are unable to determine exactly what can be done in the manner of machining parts and the best way to handle the same. The idea of tabulating work at the different machines suggested itself from tests of a 100-inch wheel lathe in turning tires, a 76-inch boring mill for boring the above, a 26-inch axle lathe for turning axles, several 37-inch mills used in driving box work, and a 42-inch wheel lathe in turning steel tired wheels, the results of which are tabulated in the manner indicated on the cards.

Referring to table No. 2, it will be found that it is possible to turn a pair of 84-inch plain tires in 2½ hours, and that a cut 5-16 inch deep, with feed of 5-16 inch, speed 18½ feet per minute, taken across a 6½ inch face, required 1 hour and 3 minutes for roughing cut. The finishing and handling of this pair of tires required 1 hour and 27 minutes, making a total, as above stated, of 2½ hours to turn the tires. The total weight of metal removed per hour in roughing cut was 291.6 pounds. This is an actual performance. The average time, however, is about 3½ hours.

Again, referring to table No. 1, it will be noted that a driving box for a 9-inch journal can be faced on both sides and counter-bored for babbitt on a 37-inch boring mill in 2 hours; then taken to slotter and slotted ready for brass and cellar in 2 hours; then brass is roughed out and fitted to box in 25 minutes at 37-inch boring mill; then brass is taken to shaper, which finishes the edges in 25 minutes, and is finally inserted in box in 30 minutes, after which box is taken to babbitting room; time for removing to mill and babbitting ½ hour; from babbitting room to planer and fitted for shoes and wedges requires about 1.7 hours per box; then cellars are fitted at shaper in 2½ hours; then it goes to drill press, where 1 hour is consumed in drilling, and finally it is fitted for journal at 37-inch boring mill in 45 minutes. The planing hours per box were taken from a test of 24 boxes, which were handled and planed in 41 hours, but all the other work was figured singly. This entire work is all done in 66 by 50 feet of floor space, and in a total time of 11 hours and 47 minutes per box. In the 66 by 50 feet space above referred to are one shaper, four boring mills, one planer, one drill press, one slotter, one drop press, babbitting fire and tools and four air hoists.

Referring again to table No. 3, a pair of 38-inch steel tired engine truck wheels can be gotten out in 1 hour and 50 minutes, and this time is an ordinary performance—four pairs being turned out in 7 hours and 20 minutes every day, and many times a good start is made on the fifth

pair; one roughing cut 5-16 inch deep and 1-7 inch feed taken across face of tire and on outer portion of flange, then a finishing tool shaped as per standard contour and full width of face of tire, to finish. Here it may be said that the first objection is yet to be heard from workmen in timing or regulating work in the manner indicated. Place a reasonable time limit on any piece of work, men to get it out in that time, and establish a method by which the work shall be done, it being assumed that men are paid the highest possible rate of wages, and if such is the case there can be no valid objection to any machine doing all that belts will drive and steel will stand to a reasonable degree. An article bearing directly on this appeared in the November issue of the American Engineer and Railroad Journal, of an 84-inch boring mill boring tires at the West Albany shops of the New York Central Railroad, which not only indicated a good performance, but that the operator was interested in the work. The satisfaction derived from knowledge that big machine work is taking the minimum time in its movement from and to several machines can only be compared to that which one has when, by changing the work movement, it is discovered that the boring mill will materially cut down lathe time, or that by applying new cutters on the milling machine half of the planer's time will be clipped off on certain work.

It has been truly said that the time lost by the improper methods of chucking work would in many cases more than counteract any time gained by proper feeds with high grade tool steels, and it is with the object of rectifying this mistake that up-to-date roads keep their tool department busy planning and making "short cut" tools. In a certain shop of twenty-six transverse pits, where a time limit of 23 days per engine is the practice, all heavy machines are taken care of by two traveling jib cranes, with five and ten ton capacity and which serve a total of 19,985 square feet. Both cranes travel the same longitudinal track, thus reducing the danger of tying up the big machines in case of a breakdown. Most of the other machines are served by air hoists on runways. The proper arrangement of these has been a very important item in labor and time saving, as will be noticed in the driving box group with its four hoists. The time for transferring is so short that no time can be charged to it.

Objections to tabulating cards are raised by many because of the possible fallibility of information and differences of opinions on the work movements. Now, this is just the reason why the tables should be prepared, for differences will naturally exist as to movement of work and time required. They will find definite information by tables, which could not be attained otherwise. There is another point in favor of the tabulated card rating system in that it shows up in the clearest manner possible the remarkable increase in output by strictly modern machinery over that of an earlier date. An example is found in the wheel lathe tests, where we find that the new lathe will easily turn out work in 3 hours which would require the old machine to get out in 5 hours; also that the new steel tire lathe will turn out work in 2 hours which took an

older tire lathe 3 hours to do. One new 30-inch boring mill will turn out rod bushings in 3 hours; the time the older machine took was 6 hours. The card system proves a valuable index in the purchase of new machine tools, giving the scope of work and the saving effected by same. In the comparison of cards between employes of a road, or between roads, discussion should produce beneficial results. In contract shops the card system is not at all new, and speed bosses, whose business it is to set a speed and feed for all kinds of work, and adjust the respective cards, hold an important position in shop management. The chief benefit to be derived from a system to my mind is, as was stated above, in a clearer and more general knowledge of what our machines can do.

Anyone visiting the storage rooms and yards where finished or partially finished stock is kept in our large railroads will readily see that an immense amount of work is ready for the heavy repairs of an engine long before it reaches the shop. This work can be definitely timed and placed on cards, which compared will show us where we stand with similar work on other roads. Individual tables for pins, studs, tap bolts, setscrews, are readily prepared and make collectively a table for such machines as Jones, Sampson, Gisholt, etc.

The table of tests serves as a proper guide in the matter of cuts. Mr. Gantt clearly explains its value in an article in the Cassier's Magazine, when he says:

"It is almost impossible to realize the difference between the amount of work obtainable from a lathe rough turning steel when run in accordance with the laws that have been determined and when it is run by the judgment simply of an ordinary, or even first-class, workman. The increase in output is nearly always 100 per cent, frequently 300 per cent, and sometimes 500 per cent."

Then in the matter of tool steel he says:

"Neither a new tool steel or a new machine tool will have the desired effect unless steps are first taken to find out definitely what the new tool steel or machine tool will do, and then a system established whereby the operator is taught how to get a maximum result."

To one making out a table of tests, the fact that high grade tools will crumble or break off a cutting edge with but one-half the cut, or even less, in an old machine, with every other condition identical, cannot be overlooked. The lost motion in an old machine is not a lost motion, but a burning motion, in its telling effect on roughening and shaping tools. This should and does affect the character of the work, and it is desirable to keep up a first-class character of work. An important consideration greatly affecting machine output, and very troublesome, inasmuch as it is a variable to a greater or less degree, is of the amount of stock to be removed. In castings we find the "variable" in its "less degree," and in small forgings it is not immoderate, but when we finally hit on the "greater degree," in the familiar form of a frame, an axle or main rod, we feel that we have come to a guessing point. This is the reason why frame and rod work cannot be definitely calculated except in

the speed and cutting list. Some of the new machines have done very good work on these parts which would not be recognized by outsiders in a card system.

The table of speeds and cuts is prepared from daily performances, and not, as in some tables, from tests of about an hour's duration, and are intended to keep the tool in good condition without grinding.

It is believed that nothing has more materially helped the output of drill presses than the table of speeds, etc., which has been placed on up-to-date machines by several shop foremen. By referring to these tables it can be ascertained at once the best results which can be obtained with any size of drill, and how many men really know how fast a drill can be driven on different metals unless a special table is prepared for them?

Feeling that the secret of success in any line lies in the degree of system which can be brought to bear, providing the time saved by same more than pays for the extra work involved, and yet providing a flexibility and adaptability to give accurate data after the system has been in force a considerable period, a few tables have been prepared of what seems to be a step in the right direction, as applied to machine shops such as are found on railway systems. Here we find interesting facts about machines and work movement confined to a circle of foremen and general officers. It is to give a definiteness to this knowledge and a general understanding to all concerned that this system of cards is proposed.

The tables do not venture to affix prices, as is done in both piece work and reward systems, for cost of material and labor are subject to change, and it is not the object of this paper to favor either one or the other. If it serves as an incentive for a more general knowledge of the kind and amount of work to be taken care of by individual machines—the correct motion of work and an increased interest in fast chucking and setting up, a table of good proportionate speeds—it will have gained its end.

TABLE NO. 1.

NAME OF PART	SIZE	LATHE HRS.& MIN.	CUTS	PLANER HRS.& MIN.	CUTS	SLOTTER HRS.& MIN.	CUTS	DRILL PRESS HRS.& MIN.	CUTS	BORING MILL HRS.& MIN.	CUTS	SHAPER HRS.& MIN.	CUTS	MILLING MACHINE HRS.& MIN.	CUTS	BABBITT HRS.& MIN.	FITTING HRS.& MIN.	REMARKS
DRIVING BOX	9" JOUR. 12" WIDE			1 HR 42 MIN	3	2 HR	3	1 HR	1	2 HR 45 MIN	5					30 MIN		INCLUDES FINISHING OF BOX BRASS & CELLAR
DRIV. BOX BRASS	" "									25 MIN	2	25 MIN	3				30 MIN	BOX COMPLETE
DRIV. BOX CELLAR	" "											2 HR 30 MIN	3					
PAIR OF PLAIN TIRES	84" DIA.	2 HR 30 MIN	2															FINISHED ENTIRE
IRON AXLE 6'-0" LONG	$8\frac{1}{2}$" x 12" JOUR.	6 HR	3															INCLUDES ROLLING
STEEL " " "	" "	7 HR	3															FINISHED WITHOUT ROLLING
ECCENTRIC STRAP	$17\frac{1}{4}$" DIA. 4" FACE									1 HR 15 MIN	3							
PISTON ROD	$3\frac{3}{4}$" DIA. 62" LONG	7 HR	3															TURNED & FITTED
PISTON SPIDER	25" DIA.									3 HR 30 MIN	4							" " "
ECCENTRIC	6" WIDE 8$\frac{3}{8}$" BORE $17\frac{1}{4}$" DIA. 4" FACE									2 HR 30 MIN	4							
CYL. BUSHING	19" x 26" INSIDE									7 HR.	3							INSIDE & OUTSIDE FINISHED
PAIR OF STEEL TRUCK TIRE	38" DIA.	1 HR. 50 MIN	2															
STEEL TIRE	56" x $6\frac{1}{2}$"									25 MIN	1							INSIDE BORE

TABLE NO. 2.

NEW 100" WHEEL LATHE							
SIZE	NAME OF PART	KIND OF WORK	TIME	AVERAGE CUTS	FEED	DEPTH OF CUT	CUTTING SPEED IN FT. PER MIN
62"	1 PAIR FLANGE TIRES	ROUGHED & FINISHED	3 HRS	2	$\frac{5}{16}$"	$\frac{5}{16}$"	$18\frac{1}{2}$
84"	" " PLAIN "	"	2 HRS. 30 MIN.	2	"	"	"
56"	4 PAIR TIRES	"	9 HRS. 26 MIN.	2			
84"	PLAIN TIRE	BORED	30 MIN	2			
56"	"	ROUGHED & FINISHED	2 HRS.	2	$\frac{3}{16}$	$\frac{1}{4}$"	16
OLD 76" WHEEL LATHE							
62"	2 PLAIN TIRES	ROUGHED & FINISHED	5 HRS	2	$\frac{1}{16}$"	$\frac{1}{4}$"	16

TABLE NO. 3.

42" STEEL TIRE LATHE							
SIZE	NAME OF PART	KIND OF WORK	TIME	AVERAGE CUTS	FEED	DEPTH OF CUT	CUTTING SPEED IN FT. PER MIN.
38"	4 McKEE FULLER STEEL TIRED WHEELS	TURNED	7 HRS. 35 MIN.		$\frac{1}{7}$"	$\frac{5}{16}$"	16
26" AXLE LATHE							
$8\frac{1}{2}$" X 12" JOURNAL	IRON DRIV. AXLE	TURNED AND FINISHED FROM 9" DIA. × 6'-0" LONG.	6 HRS.	3 AND ROLLED			
"	STEEL DRIV. AXLE	" " "	7 HRS.	3			

TABLE NO. 4.

NEW 48" PLANER							
SIZE	NAME OF PART	KIND OF WORK	TIME	AVERAGE CUTS	FEED	DEPTH OF CUT	CUTTING SPEED IN FT. PER MIN.
	SOFT CAST IRON				$\frac{5}{32}$"	$\frac{3}{8}$"	16
	WRT. IRON FRAMES		18 HRS.	2	$\frac{5}{32}$"	$\frac{1}{2}$"	16
18" DOUBLE HEAD SHAPER							
9" JOURNAL 12" WIDE	DRIV. BOX BRASS	EDGES FINISHED	25 MIN.	3			
"	" " CELLAR	ROUGHED & FITTED IN BOX	2 HRS. & 30 MIN.	3			

TABLE NO. 5.

SIZE	NAME OF PART	KIND OF WORK	TIME	AVERAGE CUTS	FEED	DEPTH OF CUT	CUTTING SPEED IN FT. PER MIN
NEW 76" BORING MILL							
62"	CAST STEEL DRIVING WHEEL CENTER	FACED AND BORED	7 HRS.	3	1/8"	3/4"	30
44"	STEEL TIRE	BORED	25 MIN.	2	1/8"	3/16"	28
OLD 84" BORING MILL							
62"	HARD CAST IRON DRIV. WHEEL CENTER	FACED AND BORED	3 HRS.	3	1/8"	1/10"	30
44"	STEEL TIRE	BORED	30 MIN.	2	3/32"	3/16"	32
48"	STEEL TRAILER TIRE	" (METAL REMOVED IN 18 MIN.)	23 MIN.	2	1/4"	3/32"	26

TABLE NO. 6.

37" BORING MILL							
SIZE	NAME OF PART	KIND OF WORK	TIME	AVERAGE CUTS	FEED	DEPTH OF CUT	CUTTING SPEED IN FT. PER MIN.
9" JOURNAL 12" WIDE	DRIVING BOX	FACED ON BOTH SIDES & COUNTERBORED FOR BABBIT	2 HRS.	2			
"	DRIVING BOX BRASS	ROUGHED & FITTED TO BOX	25 MIN.	2			
"	DRIVING BOX & CELLAR	FITTED FOR JOURNAL	45 MIN.	3			
18" OR 19" DIA.	PISTON PKG RING	ROUGHED & FINISHED	25 MIN.	2 INSIDE 3 OUTSIDE			
25" DIA.	" " "	" " "	30 MIN.	2 INSIDE 3 OUTSIDE	$\frac{3}{16}$"	$\frac{1}{8}$"	
	" " "						
30" BORING MILL—TURRET HEAD							
6" PIN $6\frac{1}{2}$" WIDE $3\frac{1}{2}$"x10" FACE	MAIN ROD BRASSES	FACING BOTH SIDES & BORING NEW BRASSES	3 HRS.	4 FACING 4 BORING	$\frac{1}{32}$"	$\frac{1}{8}$"	
" " "	" " "	FACING BOTH SIDES & BORING OLD BRASSES	2 HRS.	3 FACING 3 BORING	$\frac{1}{32}$"	"	
$6\frac{3}{4}$" PIN x $4\frac{1}{2}$" $8\frac{1}{2}$" ROD FIT	INT. BUSHING NEW	ROUGHED & FINISHED ENTIRE WITH COLLAR	1 HR. 30 M.	3 ALL AROUND	$\frac{1}{16}$"	"	
6" ROD FIT $4\frac{1}{2}$" PIN x $4\frac{3}{8}$"	SIDE ROD BUSHING NEW	" " "	1 HR.	3 ALL AROUND	$\frac{1}{16}$"	"	
6"x$4\frac{3}{4}$" ROD FIT 4" PIN x 4"	F. M. BRASSES NEW	FACING BOTH SIDES & BORING	30 MIN.	4 FACING 4 BORING	$\frac{1}{32}$"	"	

TABLE NO. 7.

NEW 24" SLOTTER							
SIZE	NAME OF PART	KIND OF WORK	TIME	AVERAGE CUT	FEED	DEPTH OF CUT	CUTTING SPEED IN FT. PER. MIN
	4 WRT. IRON FRAMES		88 HRS		$\frac{5}{64}$"	$\frac{5}{8}$"	20
18" SLOTTER							
9" JOURNAL 12" WIDE	DRIVING BOX	SLOTTED READY FOR BRASS & CELLAR	2 HRS.	3			

MR. DE VOY: I would like a few moments longer to explain some of the tables. The first table, No. 1, is one which is prepared for a collective work—that is, for instance, driving boxes—has a brass and cellar which could not be very well tabulated on one machine, so that in this space referred to this card is intended to cover the whole period; and I would like to say here that when a driving box is finished, it is turned out with a cellar in. That is done in different ways; it can be turned out faster with the cellar out, and you can turn the cellar out afterwards.

One particular feature that I would like to speak about is, that after the box is bored it is not fitted to the axle. When it leaves the machine it is finished, but there is not any considerable time placed on any scraping or filing, or anything of that sort. Now, that goes as far as freight and switch engines are concerned;. there may be some finishing done on boxes for passenger engines, but it does not amount to very much.

In the piston rod and piston spider, Table No. 1, the total time shown there is ten hours and thirty minutes. This has been frequently done in nine hours.

In Table No. 3, 3 to 4, wheels have been increased about one pair per day a great many times. There is a discrepancy there which I went over; one record was taken at one time and one another. In the 26-inch axle lathe, the feed and cut is an average cut. I have some cuts here which are 50 per cent more than that, which may be shown up later on.

In Table No. 5, the 48-inch steel trailer tire was done last week. The reason for it was that the test referred to from the New York Central put us to guessing, and we wanted to do something to equal it, and we took up a steel trailer tire. It was possible that it would break the machine, but we thought it was about time to find out whether the machine would go to pieces or not; and the metal was removed in 18 minutes; that is the actual time; the other was the time to pick the tire up from the pile and remove it either way.

THE CHAIRMAN: Gentlemen, you have heard Mr. De Voy's paper. It is one that contains information of a great deal of interest, especiallly to master mechanics and machine shop superintendents. The paper is before you for discussion. Has anyone anything to say on the subject?

I have a few words to say on the subject of establishment of machine rating. The road that I am connected with is working-largely piece work, and we are also unfortunate in being largely equipped with—I cannot say exactly old-fashioned tools, but machine tools not exactly up to date. We have found with the piece work system that it was not necessary to introduce a system as described by Mr. De Voy, for the simple reason that the piece workers, being assured that a rate once established would always remain fixed, are doing their very best to keep the output of the machine at its maximum, in order that they may earn a maximum wage.

After reading Mr. De Voy's paper I went out into the shop and found an old fellow turning tires. I asked him why he did not take more cut,

and he said he was taking all that he possibly could. We increased the feed slightly, and the machine stalled, which merely went to show that in this particular case the operator was doing as much as he could on the machine.

The tables that Mr De Voy has presented here are very interesting, and for a shop working entirely day work may do a great deal towards increasing the output of the shop; but with a piece work shop, where the men have the assurance that prices will not be cut, I do not think that that would do very much good.

There is one point that Mr. De Voy spoke of that is of vital interest, and that is, determining which machine will do the work the quickest. Some time ago we had a milling machine that was idle, and it was taking up floor space; possibly we used it once a week, and on investigation it was found that under the conditions the shop was being run it was cheaper and quicker to use a planer instead of the milling machine. After some investigation and a few changes in the machine it was found that by these changes we could use the milling machine in certain cases to better advantage than we could use the planer, and based on those lines a piece work shop can get a great deal of valuable information by these tables, but so far as increasing the output of any one machine is concerned, I do not believe they can do very much. I would like to hear from some one else on this subject. Mr. Forsyth, have you anything to say?

MR. WM. FORSYTH (Railway Age): I should think that these cards would be a very useful thing in establishing piece work prices and in determining the maximum output of the machine. I hope that you will explain how you have obtained the maximum output in some other way. I do not see why the cards apply directly to day work and not to piece work.

THE CHAIRMAN: In that connection, Mr. Forsyth, I would like to say this, that my intention was to refer to a shop which was already on a piece work basis, and where the prices had already been set, and where the assurance had been given the men that the prices would not be cut. It is a fact that in some shops working piece work, where a man increases his output and makes an increase in his wage, that a corresponding cut is made in the price of the article turned out, and as a result of that the men are very apt to curtail their output, and say, "If we earn $3.25 a day you are satisfied; if we earn $4 a day, we are cut," and a man will earn $3.25 and no more. I do not want to mention any names, but I have the assurance that that is the fact in a number of places. After the piece work prices are set and the assurance is given the men that the price will not be cut, it is to that man's advantage to earn every cent he possibly can, and as a consequence he works his machine to its utmost limit. I call to mind a man whose day rate is 17½ cents an hour, who has no trouble whatever in earning 32½ cents up to 34 cents an hour turning axles. That may seem like a great deal for a man to earn who could not do anything else but turn axles, but at

the same time the assurance has been given that man that we will pay him the price that we set, and that he is at liberty to earn just as much money as he can, and he works that machine for every ounce there is in it.

If a day-work shop were establishing piece work prices and getting ready to introduce piece work, then there is an entirely different proposition; then these cards would come in to very good advantage, and, as I said in my previous remarks, they will also come in to good advantage in determining which machine will do the work the cheapest. It may be that a boring machine will be a more economical machine than a lathe; it may be that a slotter will be the most economical machine, and so on, Gentlemen, the paper is still before you.

MR. E. J. JACKSON (C., B. & Q. R. R.): I would like to ask Mr. De Voy if the material used in these machines on this test was entirely new material or not?

MR. DE VOY: The material spoken of on the planer was a new frame; that on the boring mill was old. There are several places here in which I calculated to do the same thing twice; one is new and the other is old; it applies to both, and you will note that in several cases there is one new machine and one old machine; and right here I would say in favor of the tool machine, that one old boring mill did better than a new boring mill, and we cannot break it down. Part of the work is new and part of it is old.

MR. P. R. BROOKS (C., B. & Q. Ry.): In Mr. De Voy's idea of the card system I do not know whether he would consider it a fair proposition for rating machines, or whether it would be merely an interesting comparison, to have such a record as this made by the demonstrators of our friends, the tool steel men. At least, if it would not do for a basis of rating, the results of their performance on machines in the shop, with their own steel, by possibly two or three representatives of different concerns, would at least afford an interesting basis of comparison for the speed boss, or shop boss, or whoever has the oversight, or comparing these cards later on.

MR. H. A. FERGUSSON (J. T. Ryerson & Son): As I understand this paper, it is simply a system of keeping a record of the cuts on different kinds of work, showing what the maximum output of the machine should be, and from a hurried glance through the paper (I am sorry to say I had not read it before the meeting) I do not see any reference to piece work, and the thought arose that a system like this could be put into effect whether there was piece work in the shop or not, as in shops where piece work has never been in vogue there might be an advantage in it, for I believe this same system could be pretty well enforced on men working day work. It might mean getting a little higher grade of men, also high grade men to superintend the operation of the machines and teach the workman how to regulate his cuts as per the cards. I heard the latter part of your remarks, which were regarding piece work, Mr. Carney, and I believe this system could also be used on the day basis,

as well as on piece work. I would like to hear others of the members on this point.

THE CHAIRMAN: Gentlemen, there is room for some discussion on this subject, if anyone has anything to say.

MR. R. K. PIERCE (C., B. & Q. Ry.): Do I understand that this series of card rating is to be used in formulating a definite output for the machine, or simply to be used in making out rules or cards for the instruction of the various operators?

MR. DE VOY: It is intended for both. A man's idea of a day's work, and the method by which it shall be done.

The question of chucking is very important, although it does not come up as much in railroad work as in regular machine work. I have thehad opportunity to observe the methods of Mr. Gantt, of the Bethlehem Steel Co. and am informed that they have adopted a scheme down there of having a "Chucking Boss." They have a speed boss; they also have a boss of planers, boss of lathes, boss of drill presses, etc., and a chucking boss. First a foreman decides on what tool the work is to be turned out, and then it is turned over to the foreman of the chucking department, and his gang of chuckers put it on the machine in the minimum amount of time, then the speed boss comes along and says what speed and what tools shall be used, and then it is turned over to a dollar-and-a-half-a-day man to turn it out. Of course they have a multiplicity of similar work and they get magnificent results. It seems that it is worth while to consider this question, at least in our larger shops.

MR. IRA C. HUBBELL (K. C. M. & O. Ry.): Perhaps these remarks are not entirely germane to the paper. It occurs to me, however, that the subject illustrates a great fact, and that is this: at the present time we are spending a great deal of time dealing with effects rather than an effort to locate the cause and treat the cause.

There has perhaps never been a time in our history when railroads and manufacturers have been confronted with more serious problems than confront them today, and it seems to me that we are making a mistake in giving all our energies and time to the effect, instead of devoting careful thought and consideration to the cause, and treating the cause.

If our cellar were full of water, and the water ran into the cellar about as fast as we dipped the water out, it would take us a long time to empty the cellar; but if we will devote a little time to finding the source from which the water comes, and so stop the water running in, we can quickly empty the cellar.

We will not get the best results from those whom we employ through any effort except that which tends to bring the employer and the employe together. No matter how much ready cash we may have available, no matter what the nature of the business, we cannot establish a successful business except we have the labor that will utilize the capital. On the other hand, labor will produce capital, and the present condition of things, from my observation, which extends over a period upwards of

thirty years in employing a greater or less number of men, is due entirely to the fact that labor has not had its share of the profits of business.

We have built up the labor unions of today because of methods of the past, which have made it necessary for men to organize and as an organized body demand recognition.

It is not long since that I said to the President of one of our leading railroad systems that the railroads are unfortunately putting a premium on unions; they were forcing the men to unionize, forcing them to organize and make demands for their rights. A great deal is involved in reaching a position of justice in these matters, yet all men know that right wrongs no one. There are a great many in this room who have been in active railway life for a great many years, and they know that in their earlier experience, as in the experience of others, rather harsh methods of discipline were employed and those who are employed have in this way cultivated a habit of harshness, and it is not an uncommon thing as in my experience I meet both employer and employe, to find each calling the other hard names. You cannot obtain harmony either with axes or with hatchets, nor by calling one another harsh names; you must get together, and there is a ground upon which the employer and employe can meet, whereon neither will trespass the rights of the other.

You can't plant peachblow potatoes and raise a peach orchard. Like begets like. There is no question in the world but what a "piece system" in any manufacturing business most nearly approaches the ideal condition. Employes, as a rule, are afraid of this, because in times past employers have adopted so many subterfuges, solely for the purpose of reducing the price of labor and increasing the profit. If the profits are increased to the manufacturer, the laborer should justly participate in the gain.

I have always maintained in my personal experience that a man who employed me and failed to pay me what my services were worth, robbed me of that which was my own, and I have also felt that if I failed to earn my compensation, every dollar that was paid me, that I, on the other hand, robbed my employer just as much as though I took money from the cash drawer, or took his product from his place of business and appropriated it to my personal use. We need today to begin with the young men who enter our service, and impress upon them, by precept more than by words, that all kinds of active labor are honorable, and that the effort should be, not to see how little can be done, but, on the contrary, that the effort should be to see how nearly they can make their services so valuable to the employer that the employer shall feel that he cannot do without them.

I have been thankful in my personal experience, that when a boy of about sixteen years of age, I received a lesson from my employer that has never been forgotten. I was doing that in business hours which I should not have done, but he came to me in a kindly way and laid his hand on my shoulder with the remark that that would not do in business hours, that I should do my work. The response came quickly

that my work was done, and he said to me: "Then help some one else do his work," and the answer came quickly again, "I cannot do that, I earn all I get." In response to this inquiry as to what my wages were, I said, "Two dollars a week, and I board myself." His hand went back on my shoulder again in a kindly way, and he said, "You are the best boy we ever had, I think, but just as long as you only try to earn just what you get, you never will get any more," and I have been, oh, so thankful, and I am today, and I bear tribute to that man's memory for saying those things to me, and saying them kindly, because I went to work, and it was not very long after that that my wages were considerably increased. I did my part and he did his. We stopped the water from running into the cellar.

It is these things, we as employers need to bring to the boy; we need to bring them to the young men. We must take into consideration that those who are working by the day in our shops and elsewhere have, many of them, come up through entirely different environments than those that have surrounded us; they have not acquired the habit of correct thinking, and I am of the opinion that as you analyze this question, you will find that the cause of the present condition is due to a spirit of unfairness that has been engendered between partners in business, labor and capital, through greed, avarice, and covetousness, and what we all need most is to stop pushing one another farther away, but get close together, f or the great God who has made all that there is has made bountiful provision for all and by patient and kind endeavor to bring out this lesson to our men, young and old, I think we can do more to eradicate present troubles than we can by employing walking delegates for the employer or the workingman.

A great man has said, and he is great only because he is kind, gentle and loving:

"I believe that any man's life will be filled with constant and unexpected encouragements if he make up his mind to do his level best each day of his life."

I know that this is true for it has been proven so in my life.

The artist must first have the true picture in his thought before he can transfer it to the canvas. No man can make a picture of a locomotive, nor build a locomotive if he constantly thinks about a wheelbarrow. We are just what we most continuously hold in our individual consciousness, and employer and employe must learn easily or through suffering that we cannot escape the reaping of our own seed sowing. Cause and effect cannot be separated, and all must know that no man has the right to prevent another from working, through any act of violence.

It has been truly said, "the man who fears he will do more than his salary calls for, will never have much salary to call for."

MR. C. A. SEELEY (C., R. I. & P. Ry.): I have worked piece work myself, and I remember the time when I have finished up work and put it under the bench so that I could turn it in when I was doing other

work that was not quite so profitable, and there is no doubt that the main point in this paper is the usefulness of the card index system in gathering information so necessary in the development of new tool steel, new tools as well as the new drives and new methods which are being introduced into shop practice.

An old time boss cannot go into one of our modern shops and say how much work should be turned out on up-to-date tools that were not in the shops in those days. I could not go into a shop today and tell what the proper output should be on a milling machine, because milling machines were not generally used in shops in my time; I could not do that, and I do not know that we have the bosses over our shops today that know these things offhand, or have them stored away in their minds so that they can give them offhand. The main point is to get the information on record. I know of no better way than this adaptation of the card index and if we can cultivate a knowledge on the one side for the benefit of the employer as to how long it takes to do work, we can, on the other hand, be just to the employes in properly paying them for their operations, for we can then know by actual information gathered and stored in this card system as to what these operations are going to cost.

THE CHAIRMAN: Is there any further discussion? If not, Mr. De Voy, will you close your paper?

MR. DE VOY: Mr. Chairman and Gentlemen: If you will read part of this article you will note that it is expressly stated that it was not the intention to favor either the piece work or the bonus system. Now, I do not mean to say that I was afraid to discuss that part of the question. I have both worked piece work and superintended piece work, and I mean to say that the average piece work today done in contract shops is done about in this manner. A man takes a contract for driving boxes, for rods, for any part, he employs a certain number of men to do that work; I would rather that you would guess who makes the money. I know who makes it; whether the man who does the work, or the speed boss referred to in this article, or the one doing the work. The piece work business reminds me of a little story, for I am in about the same condition that an old colored lady was in at a meeting. The parson was berating his congregation as to their conduct, and told them that if they traveled down the narrow path they would certainly reach damnation and other things, and he got a little bit tangled up, and told them if they started down the other road, they would get to the hot place, and there was the old lady I referred to, who sat in the congregation, and she got quite nervous over the thing, she was not just satisfied, and when the parson concluded his sermon she got up and said: "Parson Johnson, if them words are true that you said, I think it is about time for the colored population to take to the woods." Now, I was afraid that if I got this piece work system and bonus system and this carding system together, you would make me take to the woods, but I believe this card system is right, and I believe that you should

establish a fair day's work for each machine, and for a man who was getting a fair day's pay, to say that that man shall get that work out in a certain time I do not believe that the man shall be driven. I want to ask you, or ask any man, if he knows at what speed any machine can be driven today? Mr. Seeley said that he did not know that he could go into a shop and tell at what speed a machine should be worked. I do not think I could, and I would like to see a man that could, and I say, the only way to do this, gentlemen, is to just take a little card and chalk up what work you have done; these machines are all numbered; it will not take much of your time; you cannot object to this system; it does not cost you anything; this was started on shop slips; it cannot be unfair to the man. He cannot do as much one day as another; he will strike a hard spot in a tire and take a hammer and chip that out. One of these tables gives a steel wheel center as being done in seven hours; I saw that done in seven hours, and I saw another one just like that done in twenty-four hours, and why? Simply because we cannot regulate the steel people, that is, we cannot take the sand spots off, and all that sort of thing, and we cannot make the steel do just what we will, but there should be a reasonable excuse as to why that was done, or was not done.

I thought perhaps that the feeds would have been discussed, or the drives, or something of that kind, and I wish to say that I had some little intention of referring to what could be taken, which I would like to present. I thought this morning that perhaps I would be called down on account of this half-inch speed for planers; that is what it should take. Here is something that was turned out this morning before I left home; there is a 48-inch planer which I think takes a half-inch cut. (The speaker here exhibited various samples and described them.) My only object in writing that paper was to give some sort of definiteness as to what we should do and what we should require.

THE CHAIRMAN: The next paper on the list today is "Machine Tools and High Speed Steel," written by your chairman, and I will ask Mr. Taylor to read the paper. The paper is as follows:

MACHINE TOOLS AND HIGH SPEED STEEL.

By Mr. J. A. Carney, M. M., C. B. & Q. Ry.

For a great many years tool steel was dependent upon carbon for its hardening qualities, and attained its hardness through a delicate heat treatment and sudden cooling, requiring great precision, and tool dressing was looked upon as the pinnacle of the blacksmith's art. Great care had to be exercised in its use to prevent overheating and drawing the temper from the cutting edge.

Since the discovery of the self-hardening steel, which contains some carbon, and the high speed steel, which contains no carbon, and requires to be run at a high temperature for best results, and will do an amount of work impossible with carbon tempering steel, the machine shop superintendent has undertaken to tone up his shop and increase the output by speeding the machinery and taking heavier cuts; but he has met with serious obstacles in the machines from the fact that they will not stand the strain necessary to get maximum results from high speed steel, and either the machine stalls or some part gives way. It is a fact that no machine shop is today fully equipped with machine tools which can use high speed steel to the limit of its endurance, nor are machine tool makers prepared today to furnish all classes of tools capable of obtaining maximum service from high speed steel.

It is not claimed there are no machine tools which will do this, but they are a small minority.

In getting bids on lathes and planers, it was specified that the lathes should cut ½ inch with ⅛ inch feed thirty feet per minute, and the planers cut ⅝ inch with ½ inch feed thirty feet per minute in mild steel. One maker said there were no such tools made, but that they could be made at an increased cost of 50 per cent of the market price of standard machines. And today machine tool makers are only commencing to build tools of the necessary weight and strength to get the full capacity of high speed steel.

The question arises, What shall be done with a lot of serviceable machines which are not exactly out of date, but which cannot keep up with the high speed steel pace? In a great many cases they can be speeded up and with moderate cuts the output of the tool largely increased, but it is found that the belting commences to give out and cast iron gears break. It is possible to replace cast iron gears with steel, but it is very probable that some other part will be unable to stand the strain and the machine will be wrecked.

The effect of belting with increased speed and cut on old tools is most disastrous, and if a tool is worked to its capacity the cost of repairs to belts and purchase of new ones will increase as much as 100 per cent. The belts, if single ply, can be replaced with light double ply at a slight increased cost and an increased service greater in proportion,

and in some cases it may be found economical to equip the machine with new cones, taking a wider belt.

The possible time saving of high speed steel, used with old and weak machines, is due to the fact that it will do much heavier work without regrinding and will finish most jobs without having to stop the machine and grind the tools. This item is a most valuable one and will do nearly as much to help a good output as the increased speed and cut.

I call to mind a driving wheel lathe that was speeded up so high that the tool steel used at the time would not stand the strain put upon it, and nearly as much time was spent dressing and sharpening tools as was used in turning tires. With high speed steel this lathe is in continuous service, but cannot pull as much as the steel is capable of cutting.

Is it profitable to continue the use of tools for general use not capable of maximum output as calculated today? And is it profitable to reconstruct such tools to give greater speed where the design does not allow of much increased strength?

In reply to the first: Where the output of a tool is in such demand that it is worked to its limit of capacity, and to increase the output of the shop would mean the purchase of a similar tool, it will pay to get rid of the original tool and buy a machine of up-to-date design, capable of maximum effort as counted today. The single tool of modern design will more than make up its cost in the extra work done. Where a tool is not kept busy all the time it may not be advisable to spend money where increased capacity would mean increased idleness; but even then there would be an argument of cheaper work on account of the faster output.

In reply to the second question: Increased speed can be obtained in most cases by increasing the speed of the countershaft, but great care must be taken not to tax the old tool beyond its endurance, or a series of annoying and sometimes expensive breakdowns will result.

It is impossible to give any rule for scrapping or rebuilding old tools, because the conditions of each shop are so different, and a tool that is very nearly worthless in one shop may be a valuable adjunct to some other shop; but as a general proposition it is advisable to purchase a new tool if it can be shown that 20 per cent of its cost can be saved per year over and above the output of the old tool.

The education of the old-time slow-speed tempered-tool machinist is no small item. This can only be done by intimate personal supervision, and it takes time to get him out of the 1-32 inch feed and 1-16 inch cut rut.

Up to the present time high speed steels have not given much success in fine work where a heavy cut cannot be taken, nor do they make good finishing tools, the reason being that the high temperature of the point of the tool necessary for good work cannot be maintained on fine cuts, and also when maximum work is being done by the tool the cutting edge is somewhat blunted and does not make a smooth job.

Among the economies brought out by the advent of high speed steel are the following: Forgings do not have to be finished so closely to make them work up economically, resulting in cheapened cost of blacksmith work; harder cast iron can be used, resulting in greater wearing qualities; tires can be turned with a minimum loss on account of being able to cut closer under the skin.

The output of the shop equipped with old tools can be increased to a considerable extent by speeding up the machinery; but the makers of machine tools have had to wake up to the fact that heavier and more powerful machines must be made to keep up with the working capacity of high-speed steel, and I venture to prophesy that heavy machinery is as yet in its infancy.

THE CHAIRMAN: Gentlemen, you have heard the reading of the paper; it is now open for discussion.

MR. HUBBELL: The paper very largely discusses itself; it does not leave very much to be said on the subject. I think, however, it is true that most of our tool makers recognize the situation that is very clearly expressed in the paper, and are making every endeavor possible to give to all users of tools a line that will meet the conditions of the twentieth century. We are doing more work everywhere now-a-days than ever before; our transportation lines are being called upon to meet problems that were scarcely dreamed of ten years ago, and I think the majority of us overlook the cause in that respect. The United States is increasing in population in the neighborhood of about three and one-half millions of people annually. Those people have to be clothed and fed and transportation companies have to carry what they consume and what they wear, and the consequence is, we have to do more work in our shops in maintaining our equipment now than ever before, and do it in a little less time than previously, and we must therefore get more work out of our tools, and I think you will find that those who are engaged in manufacturing the tools that we need in our shops will be in a position at a comparatively early day to give us tools that will take the cuts and do the work that is described in the paper.

MR. FERGUSSON: I was considerably interested in what the author of the paper said about the damage to belts when they are given more severe duty, and while that is true in connection with common oak tanned belts, I have had an experience recently that was very impressive in regard to the life of high speed belts. We have a machine that has a very high belt speed: the belt runs at a rate of 7200 feet a minute and is 13 inches wide, with eighteen foot centers, delivering 75 horse power. We tried several belts of various makes, the belt makers being a little doubtful about being able to give us a belt that would last. The longest life we had with the first lot of belts was six weeks, until finally we got hold of a specially made belt that was put on the 20th of last July, and it has been running an average of ten hours a day ever since

at that high speed, and is today as good, if not better—being a little more pliable—than it was when it was put on. I mention this incident to show that it is not a question of belts in order to get the increased speed and power in any machine tool.

MR. DE VOY: There is not any question but what this article is just about what is needed, but I believe a little more could be specified, and if that were done, it would be coming down very nearly to the point. I would like to say, in regard to the paragraph where it reads: "In getting bids on lathes and planers, it was specified that the lathes should cut ½-inch with ⅛-inch feed thirty feet per minute, and the planers cut ⅝-inch with ½-inch feed thirty feet per minute in mild steel." And a paragraph in another article in which a maker said there were no such tools made. Here is the lathe part of it; here is the ⅝-inch cut, and the ½-inch feed; the ½-inch cut and the ⅛-inch feed. We have not changed the countershaft of the belt enough to get the extra two feet in speed, but it can be done if you want to go to the trouble.

Now, as to the planer, I could not get steel, but I had a frame put on for me specially yesterday after I read your article. Now, this is wrought iron chip (exhibiting). The machine had ½-inch feed and a cut of only sixteen feet a minute; a thirty-foot speed we have not got, but it can be nearly approached, and that is the proper thing to do, I believe, to specify machines as you have designated; I believe that is just what should be done.

Now, about as to whether a machine should be discarded or not. I know a shop that has one very strong wheel lathe which turned out a pair of tires in two hours. I do not think a pair of new tires should be turned on that lathe. I believe that the older machine should be used for the new tires, utilizing both machines, and I have been making some figures as to whether the machine should be discarded or not, and really I do not know; I am undecided as to whether a machine should be discarded. There are a great many places which you do not mention where they could be used. I do not quite understand what you mean by a tool not being able to finish a part; do you mean to say that you would finish a cut with a roughing tool?

MR. CARNEY: Finish the roughing cut.

MR. DE VOY: I do not know about that. I would not use two tools, a finishing tool and a roughing tool. I wish you would explain.

MR. CARNEY: With reference to the wheel lathe in question, it would only cut about an inch across the surface, then the tool would be dulled and would have to be taken off and re-ground. The idea expressed in the paper was, that if we had four inches to face off, with a roughing cut, the tool would only face one inch and then would have to be re-ground, then another inch and then would have to be re-ground, that was with tempering steel. With self-hardening steel, the one setting of the tool will make the cut clear across, saving the time necessary to re-dress the tool, or replace it with another one. That is, if a tempering tool will cut fifteen minutes, a self-hardening tool will cut for an hour,

which means a steady service of the machine for one hour, instead of fifteen minutes, with a lapse, and then fifteen minutes more.

MR. DE VOY: I am sorry I do not just agree with you. I would use a roughing tool; if it was the fact of the tire I would use a roughing tool; a self-hardening tool. I do not know of but just one machine that is able to put a self-hardening tool out of business, and I do know only one steel that will stand that machine. I do not see where you can use a roughing tool and finishing tool to any advantage. A roughing tool, to my mind, should be curved slightly on the point and concave backward in order to take the cut that is necessary. I would shape it thus, and then a finishing cut would be taken. I do not know where a finishing cut is taken on the outside of the tire; one cut should be taken and that should be enough; that is, I mean one cut to any particular place, one roughing cut should be taken, for instance, across the face of a plain tire, and then the two cuts on sides to taper. I do not know where a finishing tool should be used there; if it were a journal you certainly would have to use two tools. That is the only thing I see in the whole article that I would not do. The rest is all right.

MR. CARNEY: I do not think you quite understand what I meant to say, Mr. De Voy. Take, for instance, boring out tires, with a roughing cut, if you have a good tool steel the tool ought to take the entire cut right through the tire. Do you get the idea?

MR. DE VOY: And deliver it; there is no question about it.

MR. CARNEY: If you try to cut with the same speed with the tempered steel, you may get two or three revolutions and you may not, before the steel has given out; then that means redressing that tool and starting over again. Do you catch the idea?

MR. DE VOY: Will you pardon me just a minute. My idea is that the proper way to bore a tire is this, and I want to go just a little bit outside of this for a minute, because I have read articles where four laborers were used. I say that there should be some way of picking that tire up with one man and the man who runs the machine; it should be placed on the machine; the man should take his tram, an ordinary rod of the right size, and then he should take a self-hardening tool started to its proper size, then get away from it and let the machine do the rest, and one cut is enough for that tire, and that tire should be turned with a self-hardening tool steel. Now, that is just as clear as I can make myself. I do not believe that old steel should be used in turning tires; I do not think that you can do anything turning a tire using old tool steel; you cannot get any results from it, I am positive of that, because I have tried it.

MR. HUBBELL: That is just what Mr. Carney says.

MR. CARNEY: That is what I am trying to get at, to show the advantage of high speed steel on shop output over the tempering steel that was used a few years ago.

MR. DE VOY: If you will eliminate the old steel from it I will understand it. I cannot connect the two.

MR. HUBBELL: In the old process the old style steel was used; now Mr. Carney recommends the elimination of that, and the use of the self-hardening steel, so you and Mr. Carney agree exactly.

MR. FORSYTH: There is a statement in the first part of the paper in regard to the amount of carbon in high speed steel which I think perhaps the author may want to modify. It states that the high speed steel contains no carbon. The old self-hardening steel contains as much as 1.3 per cent carbon, and in the change to the high speed steel, as the author says, the tendency has been to reduce the carbon to the minimum amount, and that has been replaced by chromium and tungsten and some other metals which are held a secret, but still the high speed steel does contain carbon; in fact, as I understand it, there is no steel which does not contain carbon, and I think, therefore, Mr. Carney will want to modify that statement.

I think the interesting part of the paper is that which relates to the disposition of old tools, and the statement here is quite to the point when it says that "it may not be advisable to spend money for new tools where increased capacity would mean increased idleness." And then further on it states that "it is advisable to purchase a new tool if it can be shown that 20 per cent of its cost can be saved per year over and above the output of the old tool." I hope that Mr. Carney will explain how he arrives at that figure of 20 per cent. But the suggestion I would make in regard to old tools is that they ought to have a distinct relation to the character of the shop. If your shop is a manufacturing shop, you ought to keep out old tools as much as possible, and that is the place for new tools. If you are manufacturing, you can keep a new high capacity tool employed, but if you only have a small repair shop and buy a large, expensive tool, you will probably find, as Mr. Carney says, it is not occupied half the time, and that suggests an arrangement of material and supply in a railroad so that one of your shops is doing most of the manufacturing, and that material is delivered to repair shops, finished as far as possible, and that the new tools be concentrated at the manufacturing shop.

MR. FERGUSSON: If there are any of the machine tool builders here, I would like to hear what they have to say on your charge that they cannot build a tool of the necessary weight and strength.

MR. CARNEY: If there is nothing further to be added, the discussion on the paper will be closed.

With reference to the subject of belts, the old-time machine is limited in its belt capacity by the width of its cones and it is impossible to get a larger or wider belt on the machine. That is one of the reasons why the belting bills for some machines run so high; our inability to buy enough material to do the work the machine is trying to do.

In reference to the capacity of the new machinery, I think that every machine agent in Chicago saw me down stairs and convinced me

that they either had or were building new machines which would amply come up to any desires that might be set at the present time. One gentleman in particular gave me a list of tools which were in process of design or process of manufacture, or had just been finished, that would tax the high speed steel to its utmost capacity.

In reference to discarding old tools, that is a proposition, as Mr. Forsyth said, that has to come up in each individual case. I know of two machines that were discarded from a certain shop as being absolutely worthless; the tools were not in bad condition, but their capacity both as to size and output was entirely inadequate. They were placed in a smaller shop and did very excellent work, for the reason that the demands on the tools were no greater than their capacity.

With reference to carbon in steel, I made the statement, "Since the discovery of the self-hardening steel, which contains some carbon, and the high speed steel, which contains no carbon," etc. That statement is quoted from tool steel agents. I have never made an analysis of any of the high speed steels or self-hardening steels, and I cannot say what they do contain, but not over ten days ago an agent for a certain high speed steel informed me that there was absolutely no carbon in his steel.

MR. FERGUSSON: Did you believe him?

MR. CARNEY: I always believe everything an agent tells me.

MR. HUBBELL: If there is no carbon, is it steel?

MR. CARNEY: I am not prepared to answer that question, Mr. Hubbell. I think that if it be called an alloy it would be better.

With reference to the question of discarding an old tool and buying a new one when the new tool will save 20 per cent of its cost over the old tool, I have not any definite figures that I can present before the meeting except that in specifying new machinery I looked over the matter very carefully and got an estimated saving per year for each machine and it figured up very closely to 20 per cent. I assumed the wages of a machinist at practically $1,000 a year. If we can give him a new tool which will turn out twice as much work as the old one, we are saving $1,000 a year in labor over the installation of a second tool similar to the first one and if the new tools costs $5,000 the saving in wages would be 20 per cent.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular monthly meeting of the Western Railway Club was held on Tuesday, January 19, 1904, at the Auditorium Hotel, Chicago. President D. F. Crawford in the chair. The meeting was called to order at 2:30 p. m.

Among those present the following registered:

Ault, C. B.	Forsyth, Wm.	Peck, P. H.
Barnum, M. K.	Frey, N.	Riley, G. N.
Bell, J. M.	Fry, C. H., Jr.	Robinson, Jay G.
Bennett, F. F.	Goss, W. F. M.	Royal, Geo.
Bentley, H. T.	Hall, J. E.	Shults, F. K.
Brandt, F. W.	Harris, E. K.	Sanborn, J. G.
Brazier, F. O.	Hoover, A. E.	Taylor, J. W.
Britenstein, J. F.	Humphrey, A. L.	Thurnauer, Gustav
Brooks, P. R.	Keegan, J. E.	Terrell, C. D.
Brown, J. M.	Keeler, Sanford	Traver, W. H.
Brown, R. L.	Kenyon, E. C.	Waggoner, W. B.
Crawford, D. F.	Kipp, A. R.	Walbank, R. T.
Cota, A. J.	McDonald, S.	Webb, E. R.
Cummings, E. C.	Menzel, W. G.	Wright, M. T.
Cushing, Geo. W.	Neubert, G. T.	Younglove, Jas. C.
Dolan, H. P.	Otley, Benj. F.	
Fenn, F. D.	Owen, Elmo	

PRESIDENT CRAWFORD: The meeting will please come to order. The minutes of the last meeting have been printed and distributed, and if there is no objection, they will stand approved as printed.

Next will be the report of the Secretary.

The Secretary then read the following report on membership:

December, 1903	1,078
Dropped account mail returned	4
	1,074
New members	9
	1,083

NAME. OCCUPATION AND ADDRESS.	PROPOSED BY.
Arthur Dinan, M. M., Atchison, Topeka & Santa Fe Ry., Newton, Kan.	F. N. Risteen.
Chas. Coleman, G. F., Chicago & North-Western Ry. Co., Winona, Minn.	E. B. Thompson.
J. M. Snodgrass, Instructor, University of Illinois, Urbana, Ill.	L. P. Breckenridge.
R. E. Jones, care Chicago, Burlington & Quincy Railroad, Burlington, Ia.	J. A. Carney.
A. V. Brown, Asst, Supt., K. C. St. J. & C. B. R. R., St. Joseph, Mo.	F. H. Clark, F. A. Chase.
Oliver S. Shantz, Rand Drill Co., Monadnock Block, Chicago	W. H. Traver.
A. H. Gale, Garrett, Ind.	J. W. Taylor.
Bettendorf Axle Co., Davenport, Ia.	J. W. Taylor.
Jos. M. Brown, Mgr., F. H. Lovell & Co., Chicago, Ill.	J. W. Taylor.

PRESIDENT CRAWFORD: We have two papers for today. The first one will be on "The Manufacture of Boiler Tubes," a paper written by Mr. Geo. G. Crawford, of the National Tube Co., Pittsburg, Pa., who is, unfortunately, not able to be here. The paper will be read by Mr. F. K. Shults, and we have also with us Mr. G. N. Riley, who will take part in the discussion of the paper. The paper is as follows:

THE MANUFACTURE OF CHARCOAL IRON RAILWAY BOILER TUBES.

By Mr. Geo. G. Crawford, National Tube Co., Pittsburg, Pa.

It is assumed that the majority of the members of the Western Railway Club are not familiar with the manufacture of boiler tubes, and especially that part which pertains to the manufacture of the materials from which the boiler tubes are made. This paper will therefore endeavor to describe the various processes from the charcoal pig iron to the finished tube.

PLATE 1.

Plate 1 shows several stock piles of charcoal iron—on the left, native pig of usual shape, the center pile and the one on the right being various brands of Swedish charcoal iron cast in the characteristic form of the Swedish pig.

The charcoal pig iron contains about 95.1 per cent of metallic iron, the remaining 4.9 per cent being carbon, silicon, manganese, phosphorous and sulphur.

The first problem is to separate these elements as nearly as possible from the iron. These elements oxidize more readily than iron although phosphorous and sulphur refuse to part from the iron except in basic environment. The separation is therefore made in three steps, the first aimed at eradicating particularly the silicon and manganese and part of the carbon; the second at the remaining carbon, phosphorous and sulphur;

and the third at removing the cinder which contains the oxidized form of the silicon, manganese, phosphorous and sulphur which remains in mechanical mixture with the iron.

The first step is accomplished in the refinery or run out fire. (See Plate 2.) The refinery consists of a rectangular hearth over which is a hood and stack. Blowing engines supply air under pressure through inclined tuyeres. A charge of several tons of charcoal pig is melted down for about an hour; the molten metal is subjected to the strong oxidizing action of the blast. The silicon and manganese and some of the iron oxidize, forming a cinder which floats on the metal, which is then tapped into a long, broad cast iron chill where it solidifies, forming

PLATE 2.

a large plate 3 feet by 10 feet by 3 inches thick, which is lifted out by a crane. In Plate 2, one of these plates is being removed. The plate is placed on the floor where it is drenched with water while still hot. This loosens the cinder on top, permitting its ready removal.

The quenching also cracks the plate, facilitating the breaking up into irregularly shaped pieces small enough to be handled readily. The plate metal, as it is now called, is a brittle, white metal, lustrous when freshly fractured, resembling white iron or spiegel. The plate metal contains about 96.1 per cent metallic iron, the remaining 3.9 per cent being carbon, phosphorous and sulphur. The acid forming elements, silicon and manganese, being practically eliminated, the next step is to oxidize the phosphorous and sulphur in basic environment, which is done in a "knobbling fire."

Plate 3 is a view showing one of the aisles of the knobbling department. There are ten fires in each aisle. The knobbling fire is a slightly modified form of the old Catalan forge, which in the dawn of the iron-making industry was used to produce wrought iron direct from the ore. In the upper part of the fire is an oven in which a charge of about 400 pounds of plate metal is placed. The main body of the hearth is filled with charcoal, the fire started and the blast turned on through the tuyeres at the side. The plate, which has been heated by the waste gases, is drawn into the charcoal fire and covered with an additional quantity of

PLATE 3.

charcoal, and as the fuel is consumed the fire is continually replenished by the workmen. The metal melts gradually, and drop by drop trickles down through the charcoal, losing its carbon and piling up in the bottom of the fire in pasty form. A portion of the iron is oxidized, forming a strongly basic slag, which absorbs the phosphorus and sulphur as fast as they are oxidized. The workman, or knobbler as he is called, is constantly dressing his fire, keeping the lump well into the center. About an hour and a quarter after charging "the lump is made."

The "lump" is a pasty mass of sponge iron and cinder, oval in shape, about 24 inches by 18 inches. It is lifted out of the fire by the knobbler assisted by his helper and placed on a small buggy, wheeled to a large

steam hammer (See Plate 4) and the lump hammered slowly at first into block form, and then as the mass gets more compact, it is hammered harder until it assumes the form of a bloom. On Plate 4, under the nearest hammer, is shown a ball just ready for hammering, and under the more distant hammer is the hammered ball nearly finished into a bloom. The blows of the hammer expel the cinder which is mechanically mixed with the iron so long as the cinder is fluid. The piece is continually losing heat under the hammer, and after it is hammered until the heat is no longer sufficient to keep the cinder fluid, the bloom is taken to a heating furnace and heated to a welding heat, then brought back to the

PLATE 4.

hammer and rehammered to remove a further quantity of cinder. The rehammered bloom is then put through the breakdown mill (See Plate 5), where it is rolled into charcoal bar, and the bar while still hot is sheared into standard lengths and removed to the stock bank and piled. (See Plate 6.)

The rehammering of the bloom is an innovation designed to improve the quality. The bloom is weighed after the first hammering and the knobblers and hammerman are paid by the ton on this weight, the consequent loss due to the reheating and hammering being cheerfully borne by the company in its effort to improve quality.

To make plate for 2½ inch boiler tubes, four charcoal bars about 1 inch thick by 8 inches wide by 36 inches long are piled one upon another.

On a truck (See Plate 7) are seen several of these piles ready for charging into a heating furnace. In the heating furnace these piles are brought to a welding heat and the white-hot pile is quickly thrust into the entering pass of the continuous mill (See Plate 8), where the four bars are welded into a plate. In this operation the cinder which remains after the previous hammering, rehammering and rolling into bar is still further reduced in quantity. "Here I would digress for a moment. The cinder is never entirely eliminated from charcoal iron. If there is any virtue in the claim that charcoal iron resists corrosion better than steel, it is due to the cinder which remains in it." For those users of tubes who wish to boil acid in their boilers, as platinum is too expensive, the

PLATE 5.

more cinder charcoal iron contains the better. Yet it is hard to make the charcoal iron contain much cinder and at the same time make the iron as strong and ductile as to pass the usual specifications. I am glad to note, however, that there is of late a tendency on the part of the railroads to adopt Mahomet's method of obtaining propinquity to the mountain and after many years of fruitless endeavor to obtain a non-corrosive boiler tube, they are now building water-treating plants to correct the boiler feed water.

In rolling boiler tube plate the continuous mill is found to possess advantage over the three-high. For not only is the pile firmly held and quickly welded as it passes without a stop from one set of rolls to another, but the direction of flow of cinder is maintained where on a three-

PLATE 6.

PLATE 7.

high mill it is reversed in each pass. In the final pass the plate is scarfed in order to make a proper lap, sheared into proper length and piled on a truck. (See Plate 8.)

The length and thickness and width of the plate for a given size tube is a delicate question which has been solved by experience. The plate must be enough thicker than the tube to allow for the loss by oxidation or scale, in both the bending and welding furnaces, and also for the reduction in thickness caused by the work done between the welding rolls and the welding ball. The length of plate must allow for the stretch of the material and for the crop ends.

The truck-load of plate is hauled by a broad gage locomotive to the tube and pipe department, where it is placed alongside the charging end of the bending furnace. The bending furnace is a Siemens' regenerative furnace with a flat hearth on which the plates are placed by pushing them

PLATE 8.

in lengthwise through an opening on the charging end. On the opposite end of the furnace (See Plate 9) a plate, heated to a bright red, is gripped by a pair of tongs which are then attached to a moving chain on a draw bench and the plate is drawn through a bending die.

This operation curves the flat plate into a cylindrical shape, one scarfed edge of the plate lapping over the other edge. The skelp, as it is now called, is ready for welding.

The welding furnace is also a Siemens' regenerative furnace, in which a very high temperature is maintained. The skelp is charged lengthwise through an opening in the charging end of the furnace (See Plate 10) with the lapped edges of the skelp on top.

PLATE 9.

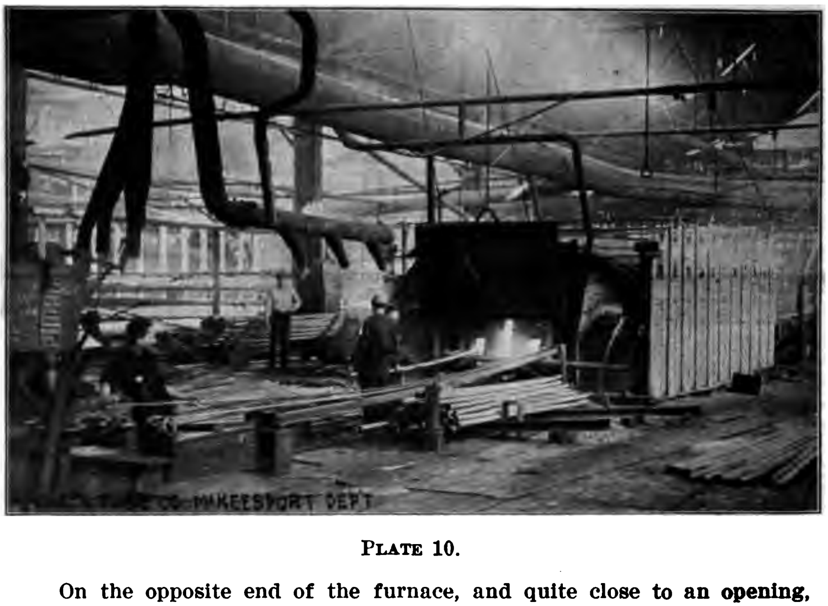

PLATE 10.

On the opposite end of the furnace, and quite close to an opening, stand in housings, two welding rolls, one above the other. (See Plate 11.) In each roll is turned a semi-circular groove of slightly larger diameter than the tube which is to be made. A welding ball is placed upon the

end of a long bar and placed between the rolls. When the skelp reaches the welding temperature it is pushed into the rolls and as the skelp passes between the rolls and over the welding ball, the scarfed edges are firmly pressed together and welded. The tube is put back into the welding furnace and again raised to welding heat and passes through the rolls and over the welding ball again, to insure a perfect weld. The bar is pulled out of the tube, the tube passed through another pair of grooved rolls which reduces it to the correct size and then through the cross rolls to straighten it, and then to the finishing department.

PLATE 11.

Before leaving the welding furnace, your attention is directed to the care taken to secure uniform gage. In order to secure enough pressure to make a good weld, the plate is scarfed in such a manner that the combined thickness of the two scarfed edges which overlap is thicker than the thickness of the plate. The pressure exerted by the top roll on the weld side of the tube as it compresses this extra thickness at the weld is transmitted to the welding ball, which in turn presses the hot wall of the tube on the side opposite the weld against the bottom roll. This action tends to make the tube thinner on the side opposite the weld. To prevent this, the plate is rolled with a "heavy center." In other words, the skelp as it lies in the furnace is just enough thicker on the side opposite the scarfed edges to allow for the reduction which it gets in resisting the thrust due to the pressure on the lapped edges in welding.

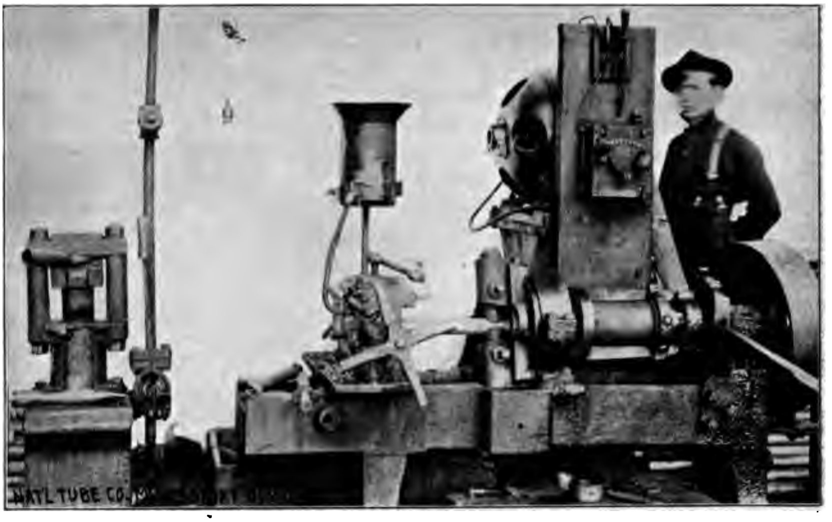

PLATE 12.

PLATE 13.

In the finishing department the tubes are cut to length in a cutting-off machine. (See Plate 12.) The crop end from each end of each tube is mashed flat (See left side of Plate 12) in order to see if the weld is good.

PLATE 14.

PLATE 15.

After cutting off, the tube is placed in a testing pump (See Plate 13) and subjected to 500 pounds hydraulic pressure. From the pump, the tubes goes to the bench back of the pump where it is gaged. While the tubes are passing the testing pumps, tests are cut from tubes in each lot and subjected to the tests shown on Plate 14, known as the ring test, the pin test and the flange test.

If the lot passes these ordeals, the bundler ties them up in neat bundles and the tubes are loaded for shipment. (See Plate 15.)

I would like to add that in the preparation of this paper I am indebted to Messrs. J. B. Ayres and F. M. Speller for valuable assistance rendered.

PRESIDENT CRAWFORD: The paper is now ready for discussion, and if there are any questions to be asked, Mr. Riley will be glad to answer them. Mr. Van Alstyne, can you say anything in regard to the paper just read?

MR. D. VAN ALSTYNE (Chicago Great Western Ry.): Mr. President, I do not believe I have anything to say. I do not know anything about the manufacture of tubes; I have a large and extended knowledge of tubes that leak; I have not very definite knowledge of why they do it. I would be glad to hear something on that question.

MR. M. K. BARNUM (C., R. I. & P. Ry.): I have noticed quite a frequent failure in boiler tubes due to pitting, and I have heard various ways of accounting for those failures, but I would like to hear what Mr. Riley would offer as a reason for the little holes forming as if they were eaten in, some of them not over a quarter of an inch in diameter, sometimes nearly round and sometimes oblong, and usually not over half an inch in the largest diameter.

MR. GEO. N. RILEY: Mr. President and Members of the Western Railway Club, in reply to Mr. Barnum's question on the pitting of boiler tubes, I would briefly state that we have just presented and read a paper on "The Manufacture of Charcoal Iron Boiler Tubes." We have endeavored to explain to you the different processes of manufacture of charcoal iron boiler tubes from the charcoal Swedish and native pig irons to the finished tube on the car ready for shipment. I am unable to give any definite information on the cause of tubes pitting in service. Every gentleman present knows as much about the cause of tubes pitting as I do.

MR. BARNUM: Mr. President, I would like to supplement my other question by one which may bring out more information. Is there any foreign substance, or cinder, or anything of similar character which might be worked or rolled into the surface of the tubes, which would cause this pitting?

MR. GEO. N. RILEY: In reply to Mr. Barnum I would state the experience of our people in regard to tubes pitting is very limited, compared with the users of boiler tubes. While we hear of a great many cases of tubes pitting, we are unable to tell the cause. If the cause is on account of imperfect or diseased material, we have been unable so far to discover it. Therefore, if it is within our power to prevent this trouble we have been unable to discover the cause, consequently it would be difficult to apply the remedy, notwithstanding we have spent a great deal of time and money to ascertain the cause of tubes pitting in steam boilers. If any of our various customers succeed in locating the trouble, and if it is within our power to prevent it as manufacturers, we would be only too glad to receive the information.

PROF. WM. F. M. GOSS (Purdue University): Mr. President, the paper is so complete in the discussion of the process as to leave no room for discussion of the question. I enjoyed the presentation of the paper and have no suggestions to offer.

MR A. R. KIPP (Wis. Cent. Ry.): Mr. President, if I remember correctly, there was a question brought up in the paper in regard to leaving a certain amount of slag in the iron as a matter of being a benefit to the tube, or a prevention of this corrosion. I do not quite understand that part of it. If there is any explanation to be made of it, I would like to hear more on that subject.

MR. GEO. N. RIDEY: We endeavor to remove the cinder in order to get the iron. Some of the processes through which the charcoal iron passes, namely, refining and knobbling, is for the purpose of removing the slag in order to get the iron. The slight amount of cinder that is left in the iron after passing through these processes assists very materially in welding the pile as well as welding the tube.

MR. KIPP: Was it a misunderstanding on my my part that some of the slag is left in the iron to keep the tube from corroding?

MR. GEO N. RILEY: It is claimed by some authorities that the reason a charcoal iron tube will resist corrosion much better than steel, is on account of the cinder contained in the composition, but in our manufacture we aim to separate the cinder from the iron in order to get a good strong iron that will meet the requirements of the various specifications for charcoal iron tubes.

MR. KIPP: That is what I want I want to understand.

PRESIDENT CRAWFORD: Is there any further discussion? If not, we will proceed with the other paper, which is, "Economy in Railroad Operation," by Mr. W. B. Waggoner.

MR. W. B. WAGGONER: Mr. Chairman and Gentlemen of the Western Railway Club: The position taken in this paper is an extreme one, but that is perhaps an advantage if one desires to bring out all sides of a question, and I am not averse to changing my point of view, in the light of greater knowledge on a subject. The paper I have to present is as follows:

ECONOMY IN RAILROAD OPERATIONS.--(A SUGGESTION.)

By W. B. Waggoner.

Railroads are the most expensively administered organizations in the world, aside from city governments. Also, the real or actual cost that will completely cover any particular item of operation or manufacture, is an unknown element in railroad accounting.

That these are facts is well known to those who have studied the problem of costs in railroad operations, and must be so from the very nature of the conditions under which railroads are operated.

Having had charge of the maintenance of equipment accounts of a large company for a number of years, an excellent opportunity was found during the hard times from '93 to '97 to study the subject of economies, as every item of expense was carefully examined with the idea of greater economies. The results showed most conclusively that something can be done along the line of more complete accounting and reduction of expenses.

The ideas given in this paper are the result of that experience and a study of the subject from a broader point of view.

Railroads operate over wide expanses of territory, are directly administered by men who have no personal interest in the question of economies and who have all they can do to keep things moving. One great reason why no personal interest is felt, is, that the official in charge has no financial interests at stake, and being on a salary, may be looking for another position tomorrow. A change of management nearly always makes more or less changes in minor officials, and often a complete one in heads of departments. Such changes are occurring monthly, and but a few days ago I overheard a remark to the effect that "if Mr. X. gets to be General Manager of a certain road Mr. A. would not last fifteen minutes." So it is not reasonable to expect men, under such circumstances, to lay awake nights or work overtime, trying to save dollars. If one can make a record as an active man and a hustler he is doing all that he feels is necessary, both for himself and the company.

All will agree, I think, at least those who have had direct experience in the operating departments, that the man has done all that can be reasonably expected.

It takes all of an officer's time to keep things moving during periods of activity, and this is just the time that expenses get the upper hand of everybody. Officials rarely have the time or opportunity to study economies during periods of heavy business, even if they are anxiously inclined to do so.

Every Superintendent, Superintendent of Motive Power, or Master Mechanic can testify to the fact that he has seen instance after instance where he might better conditions and consequent saving, if he only had time to "go after it."

The general situation as here outlined may be fully appreciated, and an operating officer see the thing to be done, and yet be helpless; so what is proposed is to give him assistance by establishing a co-operative bureau—not a department, to be known as the Bureau of Economies.

This Bureau must be general in its character, directly under the supervision of the General Manager. It will be an office of record, and the head of the bureau will have no executive authority whatever. Here, in my opinion, lies the secret of the success or failure of such a bureau, which must be entirely co-operative and advisory in its conception, organization and administration. It must not interfere with the responsibilities or authority of any executive officer in charge of a department.

With a man that can see without spying, can hear without sneaking, that can co-operate and advise without interfering—with such an official head to the bureau, it could be of enormous value.

The organization should be as simple as possible—having for a large company: A Head of the Bureau, an assistant in charge of transportation economies, an assistant in charge of maintenance of equipment economies, an assistant in charge of M. of W. & S. economies, a chief clerk to co-operate with the three assistants.

On a small line, the Head of the Bureau could look after all departments, but this would not be possible on the large organizations we have today.

Standing committees should be organized with the superintendent of the department as chairman, Head of the Bureau of Economies, and the official next in line to the superintendent of department.

For a Transportation Division, the committee should consist of the superintendent of the division, Head of the Bureau of Economies, or assistant in charge of transportation economies., and official next in line to superintendent.

The Head of our Bureau should be constantly in touch with all operating details and operating officials—he should suggest to the heads of departments any points he may observe that could be investigated to an economical advantage, and particularly look for suggestions from such official heads.

Where a general office is concerned in direct operation, as General Superintendent or General Superintendent of Motive Power, these officials should be ex-officio members of the committees, advised of all that is being done and to act on the committees if they so desire.

The Bureau should collect and keep a complete record of all operating statistics and expenses. In the case of special investigations, should furnish all clerical labor if necessary, and co-operate directly with the official in charge. The results are for the head of the department, and it is for him to decide upon the course to be followed in carrying out any recommendations of the committee. Only in this way can be preserved the dignity and responsibility of the operating official, and make the Bureau something to be used and appreciated. Any system of spying is disgraceful and disorganizing; it can only lead to bad results in the end, both to the department and the official in charge.

The Head of the Bureau of Economies should report directly to the General Manager, who is thus fully advised of what has been done. The Head of any department concerned in the report must therefore advise the General Manager of the action taken, either that the recommendations have been acted upon, or reasons given for not acting.

The General Manager sees wide discrepancies in operating expenses on different divisions; the Bureau can look into them and would find, probably, bad accounting in some cases, in others bad management.

On all railroads, it is safe to say, there is more or less bad accounting. The auditors are usually satisfied if reports are on time and balanced up correctly, but whether care has been exercised in the distribution of labor and material to the proper expense accounts is a matter about which an auditor cannot know, unless some one from the accounting department is constantly in touch with the clerks in direct charge of the distributions.

Railroads do not, as a rule, establish any other records than those required by the auditor, and his office is not specially interested in how to economize.

Administration without proper records can never be truly economical, for you cannot tell what was done last month as compared with to-day. The records needed differ from the auditor's requirements and are the subject of special study for each point of operation.

The question of special accounting for the purpose of economies is one that railroads could take up with great advantage. There is not a railroad in the country that can tell the actual or complete cost of any particular operation, of train service, track department or shops. It is a case of estimates, guesses everywhere—more or less accurate, depending upon the intuition of the guesser. I once astonished our chief engineer by my rule for actual costs based on estimates, which was to get the estimate as carefully as possible and multiply by three. He was more than half inclined to agree with me, but said we could never get an appropriation on that basis.

A new general shop was built that was not to be attached to any particular division, and at my solicitation, the Superintendent of Motive Power obtained from the General Manager his consent to put the shop on the basis of a private industry—i. e., the plant exists for the production of work—charge everything about the plant to the work, and bill other shops for all the work done. The result was that the costs at this shop appeared to be from 40 to 60 per cent greater than at any of the others. I say appeared, because in reality the cost was less—it was a case of accounting, as the other shops never were able to get at the true costs, and I had great difficulty in proving it to the master mechanics. A large number of items are made at railroad shops that can be purchased cheaper outside, if their actual costs were known, but many master mechanics will say that flat cost and ten per cent is close enough to real cost, for the statement that the shops can make a thing cheaper than it can be bought—forgetting that heat, light, power,

handling materials, general labor, shop repairs, supervision, etc., are all legitimate parts of the cost per unit. A manufacturing plant that did not take these items into consideration in figuring cost would be bankrupt in a year.

Master mechanics, shop foremen and shop clerks need education along the line of more careful economical accounting, and this education can best come from such a place as our Bureau of Economies.

The scientific method is now dominant in all branches of business. Science means knowledge, and its significance becomes evident as soon as it is seen that knowledge is the opposite of guesswork and speculation; that the determination of facts is the antithisis of the appeal to the imagination as a basis for guessing at the cost of work, much of which has been and still is a fairy tale evoked from the inner-consciousness of imaginative foremen.

Whatever work is being done, the fact of its cost is the first requirement, preliminary to the further facts to be discovered, in order that it, and every other agency of nature as well as art, may be directed to an economical product.

A scientific method in accounts is as fundamental in educating men who are to have charge of work as any other part of the system of technical education, and this is now being recognized to some extent by technical schools.

The Bureau of Economies involves a close connection with all the producing elements, and its head and assistants should have such familiarity with the work as to be able to intelligently discuss any details involving questions of economy with the heads of departments.

The Bureau must be prepared to meet the demands of a large variety of interests after sufficient time has been allowed for its complete organization. The final form and extent of this Bureau must necessarily be determined by experience and any preliminary outline must be provisional. The Bureau will be subject to constant change, amplification and improvement in detail, as the progress of the work permits or compels, until the adjustment to the requirements becomes perfect.

Ultimately such a Bureau will be doing all that can be asked of it, and it is possible that a technically educated young man entering it would find himself as well, if not better, fitted for promotion to an executive position in a shorter time than might be possible in other lines.

The broad and accurate knowledge to be obtained in such environments would make his progress into the executive departments, if he had the proper qualifications, as smooth and easy as his talents and industry would permit.

It may be questioned if a man strong enough for the head of such a Bureau as we have described, would accept such a position, but I am positive that every railroad company has a number of men in its employ, who have all the qualifications for promotion to department

heads, yet lack that most important one of executive ability. Such a man could well take charge of the Bureau and make it a success, as he would be better able to investigate and co-operate, without interfering with administration. Whereas a man of good executive ability might be too much inclined to forget the co-operative spirit and do things which would antagonize the official heads of departments—all of which much be avoided if success is to be obtained.

And success can only be secured by systematic education in economic production. In no department is this more essential than in engineering work, where a perfect economic system is most essential to successful operations.

Our Bureau also could be of great help in the adjusting of labor questions. An element that is aside from the immediate control of labor can handle questions of differences much better than those in direct supervision, and the reason for this is that the outside man feels he can afford to be on the generous side, and experience has proven that the generous side will win in the end.

The ordinary man is full of personal prejudices; in every direction we see men overrated by their superiors through friendships and others, which is more commonly the case, degraded through dislike or underrated through ignorance of what a man is really worth.

It has been found in promoting men in shops that the best interests of the company are conserved by a transfer to another shop among strangers where the personal element is removed, and this same argument holds good in the settlement of labor questions and the Bureau would relieve the heads of departments of many disagreeable positions.

The Bureau would have records of the rates paid at various points, and when possible on other roads, would be familiar with the conditions at each shop or on each division; would have the time to thoroughly investigate complaints, and more than likely be able to convince the men, if the complaint is not a fair one, and thus settle the matter.

Many times dissatisfaction comes through bad conditions and unfair treatment at the hands of foremen. In many cases the conditions and the unfair treatment are imaginary, and the shop officials are apt to ignore such complaints without trying to settle them, thus sowing the seed of deeper discontent. Our Bureau ever on the watch for such things would step in and heal the trouble before it could ever get to such a serious point as a strike.

The wage-earner is also disturbed by the fallacious array of one-sided statistics put forward by the agitators and some socialistic writers. The fact is either not known or ignored that the laborer is better paid, and able to get more physical comforts, together with a better education for his children, than ever before in the history of the world. Also that employers are more willing to help the wage-earner to better conditions, if he will but stop kicking long enough to look into the other side a little. But this is not a paper on the labor question, this digression is only to emphasize the fact that the Bureau

could be a great and saving help in this important direction, because the great unrest of labor will only be settled when the employing side takes enough interest in the subject to educate their employees to a proper appreciation of some of the commonest laws of life and trade.

The solution of the economic problems is not in the antagonism and abuse of one department by another; not in one official condemning or criticising another, nor in the employees cursing the officials, but in honest, sympathetic co-operation between both sides.

You have heard the story from Aesop, illustrating co-operation: "A blind man and a lame man meeting upon the road and commiserating with each other on their hard lines, the lame one said: 'If you will be feet to me, I will be eyes for you'—so the blind man carried the lame man, and the lame man guided the blind man. Both men arrived at their journey's end quickly and without accident." So it must be with officials and employees. Railroads are helpless without labor—and labor has always been blind to its best interests.

The greater intelligence, administrative elements and all-around business abilities are found on the employer's side, and the wage-earner ought to be recognized to the extremest degree by the employers and guided by them. Through the influences of our Bureau both sides could work together and the employer keep a strong hold on the administrative elements that he ought not, and will not give up, as is demanded by the labor organizations.

The time is rapidly approaching, in fact now is, when dividends will be a more important element in railroad operations than has been the case. Earning fixed charges and operating expenses has been only necessary to keep the property out of the receiver's hands. There is no direction where net earnings can be augmented as easily as by the cutting down of wasteful and unnecessary expenditures, and a Bureau of Economies can be made a most helpful and efficient adjunct to the increasing of that last column of the statement, which the General Manager always looks at first: "Net Earnings."

PRESIDENT CRAWFORD: The paper is now before you for discussion.

THE SECRETARY: Mr. President, I have one or two written discussions from members of the club, which I would like to read.

The Secretary read the following discussions:

MR R. H. SOULE: At one place in his paper, Mr. Waggoner says:

"There is no direction where net earnings can be augmented so easily as by the cutting down of wasteful and unnecessary expenditures."

This is, of course, the keynote of Mr. Waggoner's whole argument, and to all who are acquainted with the details of railway operation is a self-evident proposition.

In another place, he says:

"The real or actual cost that will completely cover any particular item of operation or manufacture is an unknown element in railroad accounting."

And, still again, in another place:

"There is not a railroad in the country that can tell the actual or complete cost of any particular operation of train service, track department or shops."

It will seem to many, I think, that these statements are somewhat too sweeping, for there are certainly a great many items of the cost of operation which are accurately known on most railroads. The fact remains, however, that the determination of the costs of railroad operation, whether in general or in detail, is susceptible of a great deal more refinement than has usually surrounded it, and that fact, of course, is what Mr. Waggoner has in mind. To quote again, he says:

"A large number of items are made at railroad shops that can be purchased cheaper outside."

While this is undoubtedly true of some, and perhaps of many shops, it is not necessarily true of all shops, and in fact, there are evidences that it might be truly stated, on the other hand, that there are a large number of articles that are purchased in the market that can be manufactured at railroad shops more cheaply.

Further on Mr. Waggoner says:

"Railroads do not, as a rule, establish any other records than those required by the auditor."

This was, in my judgment, absolutely true twenty years ago, but since that time a great many railroads have introduced accounts or sub-accounts in several departments not required by the auditor at all, but established by the heads of those departments to facilitate accurate cost keeping and to improve their records of operating data. Mr. Waggoner will probably remember that what is known as the Shop Order System was established in 1883 on the railroad with which he was for so many years connected, and will bear in mind that that system of shop accounting was not required by the auditor, but was simply introduced and established on the initiative of the Motive Power Department, with the auditor's consent, however; but it was simply what may be called an intermediary account, through which charges for labor and material were passed and assembled, so that footings could be ascertained and recorded to represent the cost of individual jobs of work done in the shops. The monthly statements which finally reached the auditor were in no way modified from the forms previously used, and, in a certain sense therefore, he was not in any way interested in these Shop Order Accounts.

Elsewhere Mr. Waggoner says:

"Officials rarely have the time or opportunity to study economies during periods of heavy business."

This being the case, the question arises, why officials do not study economies when business is slack. Certainly by so doing they can estab-

lish accounts and records, the keeping of which is simply a clerical matter, and the operations of which will be practically automatic after they are once formally established.

Mr. Waggoner says again:

"I once astounded our chief engineer by my rule for actual costs, based on estimates which was, to get the estimate made as carefully as possible and multiply it by three."

While railroad estimates have been proverbially inaccurate and unreliable, it does not seem to me that the situation is hopeless, or that there is anything impossible about getting estimates which are reasonably accurate and on which sufficient reliance can be placed to go ahead and act on them without adding any percentage to cover uncertainties and variations. On one railroad, with which I was formerly connected, the best man in the drawing room was detailed to make estimates for the superintendent of motive power. He was given the title of assistant engineer. His office was adjacent to that of the shop clerk of the principal shop of the system and to the general storekeeper of the whole system. He was put into working relations with these two offices, and gradually accumulated in his office a great deal of tabulated data relating to costs of labor, material and completed jobs. He was provided with certain blank forms which were used in making estimates. It was his business to make up complete bills of material and to complete the estimates of the cost of all materials which entered into the construction of jobs. When it came to the item of labor, however, it was his business to furnish direct to each department foreman of the shops the necessary data as to the work to be expected of that department, and on receipt of this information the foreman of the department made his estimate of the labor involved. His estimate was passed up to the master mechanic who, if he approved of it, signed the papers and passed them along to the assistant engineer. Within a year this man had become so expert and efficient that he produced estimates which were remarkably close. Many instances might be stated, but one is sufficient. It related to a job of building construction which involved labor on the part of laborers, masons, carpenters, blacksmiths, machinists, tinsmiths and erectors. The estimate placed the cost of the job at about $3,000, and when the work was completed, some three months later, and the cost finally totalized, it was found that it varied from the estimate by slightly less than $75. This was not an exceptional case but only an average sample.

Mr. Waggoner's note of warning is well sounded, and certainly every railway officer ought to have his Bureau of Economies on which he can lean, but it seems to me very doubtful if it would work out well to have one Bureau of Economies for the whole road. It seems to me rather that each department ought to have its own bureau. For instance, the superintendent of motive power of a large system could readily organize his own Bureau of Economies entirely within the limits of his department,

and could, in my judgment, get much better results in that way than if depending on a bureau over which he had no control, but which was under the direct supervision of the general manager.

Is it not a correct principle that, when the cost of a job is to be recorded, the clerical work of assembling the items of labor and material should be done in the office of that officer first in the series, from lower officials to higher officials, who has complete jurisdiction over the work done? For instance, take a job of work which is done and completed at any one shop, should not the cost of that job be recorded by the shop clerk of that shop? Similarly, take some matter of cost which covers the whole road, as, for instance, the cost of repairs of locomotives per mile run, should not the record of that cost be kept in the office of the Superintendent of Motive Power, by the Accountant of that department, who is generally or often known as the Motive Power Clerk?

Again, if a large job is to be undertaken, involving the co-ordinate labor of several different departments, should not the record of the costs of that job be kept by the auditor of the road? For instance, take the case of new shops, such a job may easily cost over $1,000,000, and will probably involve labor in the accounts of the Engineering Department, Maintenance of Way Department, Motive Power Department, the Transportation Department, the General Storekeeper's Department, the Purchasing Agent's office, and quite likely the Legal Department. It would seem that in such case as that the records of the cost of work ought to be kept in the auditor's office, as he is the only officer who, in a certain sense, is superior to all these, and to whom all these others pay tribute in the matter of accounting.

As bearing on this general question, it may be stated that the catalogue of the American Society of Mechanical Engineers, recently issued, includes the names of some five or six men who give their occupations as being that of an "Estimating Engineer," and it seems reasonable to suppose that there is a great opportunity for the estimating engineer in railroad service; but, it being conceded that every railroad is in need of a Bureau of Economies, the main question is: Whether it is better, as Mr. Waggoner suggests, to have one central Bureau of Economies for the whole road, or for each department to have its own bureau. Personally, I believe in the latter method.

GEORGE WELSBY SCOTT: According to Mr. Waggoner, "Railroads are the most expensively administered organizations in the world, aside from city governments."

He also claims that: "The real or actual cost of any particular item of operation or manufacture is an unknown element in railroad accounting."

He further states that railroads "Are directly administered by men who have no personal interest in the question of economies and who have all they can do to keep things moving."

And he informs us that "One great reason why no personal interest is felt is that the official in charge has no financial interests at stake, and being on a salary may be looking for another position tomorrow."

Then, because of the probability of managerial and official changes, Mr. Waggoner says: "So it is not reasonable to expect men under such circumstances to lay awake nights or work overtime trying to save dollars. If one can make a record as an active man and a hustler he is doing all that he feels is necessary, both for himself and the company."

And concerning this conclusion, Mr Waggoner further states: "All will agree, I think, at least those who have had direct experience in the operating department, that the man has done all that can be reasonably expected."

Further on, Mr. Waggoner states: "Officials rarely have the time or opportunity to study economies during periods of heavy business, even if they are anxiously inclined to do so. Every Superintendent, Superintendent of Motive Power, or Master Mechanic, can testify to the fact that he has seen instance after instance where he might better conditions and consequent savings if he only had time to go after it."

* * *

Mr. Waggoner treats his subject boldly and frankly; and having concluded his exposition of administrative laxities and operative inefficiencies, he suggests, as a corrective, the institution of a Bureau of Economies, and he particularly states that the bureau is not to be a "department," but an organization co-operative and advisory, without any executive authority whatever.

According to Mr. Waggoner, the head of the bureau should be constantly in touch with all operating officials and operating details, and the bureau should collect and keep a complete record of all operating statistics and expenses. The bureau is also to be concerned with general and special accounting, the formulation of correct estimates and the education of master mechanics, shop foremen and shop clerks in the line of more careful economical accounting.

Mr. Waggoner also states: "The Bureau of Economies involves a closer connection with all the producing elements, and its head and assistants should have such familiarity with the work as to be able to intelligently discuss any details involving questions of economy with the heads of departments."

And on page 5 Mr. Waggoner remarks: "Our bureau also could be of great help in the adjusting of labor questions. * * * The bureau would have records of the rates paid at various points and, when possible, on other roads. It would be familiar with the conditions at each shop or on each division; would have the time to thoroughly investigate complaints, and more than likely be able to convince the men if the complaint is not a fair one, and thus settle the matter."

"Many times dissatisfaction comes through bad conditions and unfair treatment at the hands of foremen. In many cases the conditions and the unfair treatment are imaginary, and the shop officials are apt to

ignore such complaints without trying to settle them, thus sowing the seed of deeper discontent. Our bureau ever on the watch for such things would step in and heal the trouble before it could ever get to such a serious point as a strike."

In another part of the paper Mr. Waggoner says: "Standing committees should be organized, with the superintendent of the department as chairman, head of the Bureau of Economies, and the official next in line to the superintendent of department." And in the case of special investigations, "The results are for the head of the department, and it is for him to decide upon the course to be followed in carrying out any recommendations of the committee. Only in this way can be preserved the dignity and responsibility of the operating official and make the bureau something to be used and appreciated."

And with further respect to this point Mr. Waggoner states: "The head of the Bureau of Economies should report directly to the General Manager, who is thus fully advised of what has been done. The head of any department must, therefore, advise the General Manager of the action taken, either that the recommendations have been acted upon, or reasons given for not acting."

* * *

With no more ceremony than he exercised in his exposition of what he considers the condition of the executives and officials in general concerned in railroad management, Mr. Waggoner creates his Bureau of Economies, and at once imbues it with the qualities of omniscience and omnipresence. For this bureau nothing is too deep, or too abstruse. All things are alike to it, from track matters up and through the whole range and sequence of equipment, motive power, traffic and operating. Even the auditing department is but an incident in its infinite comprehension. And just why the legal department is not included in its scope is not stated. The labor question is, however, abundantly cared for and in this Bureau of Economies railroad companies are promised a means whereby strikes and feverish discontent may be avoided. For has not Mr. Waggoner told us that his "Bureau, ever on the watch for such things, would step in and heal the trouble before it could ever get to such a serious point as a strike."

And has he not also told us that this ever thoughtful bureau "Would have the time to thoroughly investigate complaints, and more than likely be able to convince the men, if the complaint is not a fair one, and thus settle the matter."

And may we not here ask—and what about the complaints that are fair ones? Will the bureau so smoothly and so convincingly arrange matters with the company?

It is to be regretted that Mr. Waggoner does not enter more at length concerning the peculiar and favorable environment from which he would secure the personnel of his bureau. True he is "Positive that every rail-

road company has a number of men in its employ who have all the qualifications for promotion to department heads, yet lack that most important one of executive ability."

But is this sufficient? It would appear not. Certainly not if the members of the bureau—including its otherwise capable but non-executive head—are taken from the salaried class, for has not Mr. Waggoner told us that "One great reason why no personal interest is felt is that the official in charge has no financial interests at stake, and being on a salary may be looking for another position tomorrow.".

And if we are willing to join with Mr. Wagoner in assuming that such excellent characters as he depicts would be likely to take a personal interest in their work, can he assure us that they, unlike their coarser minded fellows of the official rank, would not be "looking for another position tomorrow."

This is an important point; for if Mr. Waggoner is going to procure his bright bureau men from the opulent class—that in which there exists no occasion for the disquieting thought of a position tomorrow or, indeed, at any time—how can we be assured that there will be enough of these favored ones to supply the many bureaus required for the several railroad companies? Then, too, who will guarantee a continuance of their "personal interest" in the multifarious duties assigned them?

It is, perhaps, fortunate for Mr. Waggoner's railroad officials that he did not give executive authority to his Bureau of Economies; for with the astuteness of this bureau it is not conceivable that its members could do otherwise than discharge the entire list of officials because of the lack of interest and ability, and even the absence of self respect which Mr. Waggoner so clearly ascribes unto them. And then having performed this commendable duty, and having in due course selected competent people to fill the several positions—no easy task, to be sure, seeing there are so few available ones who do not need a salary—there is only one other thing to be done by this bureau, and that is—discharge itself. This, in fact, is a logical sequence. For if the officials are inefficient, and Mr. Waggoner's argument shows them to be such, then their replacement is an economical necessity. On the other hand, if the officials—old or new—are held to be competent after due consideration by the advisory bureau of economies, then wherefore the occasion for the further existence of said bureau? Was it not created by reason of the inefficiency of Mr. Waggoner's officials? And granting the selection of proper and competent officials—surely a no more difficult task than the selection of members for this wonderfully, comprehensive and tactful bureau—what reason could be held for its further continuance, seeing that the need, the occasion, no longer exists. It would appear that the economically minded bureau would be first to concede this point and at once send in its resignation.

* * *

A railroad company is large in proportion to the territory covered and the extent of its traffic. But whether large or small, the degree of economy

with which its affairs are administered and its operations conducted will depend upon a multitude of circumstances not all of which are to be found within the direct province of the mechanical, operating and auditing departments.

That there is an ever existing opportunity for the exercise of economical measures is a truism. The occasion seemingly keeping pace with the advance in knowledge of methods, processes and appliances. That which may have been the best in other days being, in some instances, economically inferior to that which is attainable today.

And how shall these better and improved measures be applied so that this or that railroad company may reap the economical results to be gained thereby? What other way is open than through the direct personnel of the executives? What if the advisory bureau of economies is rich in suggestion, fruitful in resource, and smooth and tactful in its relation with the several departments—is there yet not always some one who is to say—"Go ahead?" And if the executive or ruling officials—salaried or otherwise—do not for this or that reason see fit to adopt the various recommendations made, perhaps time and again, by the bureau of economies, how long will even the apparent usefulness of the bureau be recognized?

Is it not reasonable to suppose that in good time the bureau would either dominate or be dominated? And if the former, then the bureau would become the executive in fact, leaving the holders of the titles or positions as figure heads, or automatons, to be moved in accordance with the dictates of the dominating bureau. On the other hand, is the helplessness and uselessness of a dominated advisor, whether that advisor be a bureau, or other body, or a single personage; for the advisor then becomes the automaton, and a pitiful object it presents under these stultifying conditions.

Clearly, it must be conceded that if good, bright and capable men may be secured for this or that bureau of activity (for, after all, the reformer is essentially an active personality), then the same men may be procurable for official positions. And it surely is no argument on the part of Mr. Waggoner to ascribe less admirable qualities to the officials than he bestows upon the people of his bureau. So that, in the final analysis, we must have resort to the executive organization as that which admits of any improvement whether in administration in general or operation at large.

Given as president, or executive in chief, a broad minded, generous man of large capacity and abiding faith, and he warmly and loyally supported by his competent staff of, say, general manager, superintendents, and lieutenants at large, as the case may be—and these in turn no less willing to be broad minded, generous, and trustful with respect to those in service with them, regardless of degrees, and you will have a bureau of economies at first hand. A bureau at once upon the spot, bright, cheerful and alert. And what if the pressure of business requires most of them to be actively engaged in keeping "things moving"—is this

not the very fundamental requirement—the essential function—of a transportation company? And who better able to improve upon existing conditions than the active and efficient ones who are constantly wrestling with the occurring and recurring problems?

Nor let any of us acquire a wrong notion from the charge that because one is in a salaried position he must necessarily be indifferent to the economical interests of his company and "may be looking for another position tomorrow." For if any of your subordinates are of the order describes by Mr. Waggoner, then look to it that your treatment of them is of the nature to engage their interest. Place some trust in their ability; assign them responsibilities—small or great as the case may be; and not only will interest be awakened, but the fertility of other minds will be added to make your work successful. And as one would look for loyalty and interest on the part of one's subordinates, and would do that to engage it, so in turn may he be loyal and interested in the work assigned to him by those higher in authority.

PRESIDENT CRAWFORD: We will be glad to hear from members that are present on this subject.

PROF. GOSS: In his introductory remarks Mr. Waggoner has warned us that his paper represents an extreme view, and having such a warning, we should not be easily startled or surprised. I must confess, however, to having been very greatly surprised by portions of the paper, for I have been taught to believe that even an extreme view should be true. Is it true that "railroads are the most expensively administered organizations in the world aside from city governments?" Any corporation is an organization. A bank which, through the most reckless mismanagement, has been brought to failure, is an organization. Any newly launched trust, the chief purpose of which may be the support of high salaried officers, is an organization. The administration of such organizations as these may fall very low in the scale of efficiency, and yet the statement which I have quoted places railroads, not some particular road, but railroads in general, below the least excusable and very meanest of these. Certainly the management of our railroads deserve no such arraignment.

I know not what the real facts may be, but I fancy that if a fair basis of comparison could be had that it would then appear that the better railways are managed as economically as the better class of corporations devoted to manufacturing. This, however, is merely my personal opinion based upon such observation as I have been able to make.

Another statement which shocked me as I read it was one to which Mr. Scott has already called attention, namely, that which implies that salaried men have no personal interest in this work; that it is only when men are financially interested in the outcome of their work that they will exert themselves to secure economy in the administration they serve. Such a view puts a low estimate on the purposes of men, an estimate too low to have much significance in its application to the great mass of men who are administering the affairs of American railroads. I believe

that as a rule railway men are loyal to their trust. They are often charged with great responsibilities which serve to bring out the strongest and best qualities of manhood. Few men can long stand as the administrator of a great trust without feeling that the trust has something of divinity in it. Inspired by such a feeling, I believe that the average railroad official on a salary carries his responsibilities as seriously, and is as untiring in his efforts, as would be the case if he shared in the profits of the company he serves.

MR. C. B. AULT (Homestead Valve Co.): Mr. President, the paper infers that there are a great many officials appointed through favoritism. This may be, but I think if we look over the railway officials of our own acquaintance, we will find that they were not appointed through favoritism, through being related, or friendship, although some officials have no doubt been appointed in that way. But how does a man become a favorite? A man becomes a favorite by doing his work properly, by looking out for the interests of employers and those over him.

I would like to give a little illustration which I think applies. I have a boy who is ten years old. Last winter he was having considerable trouble at school. I thought he was being abused; I did not take the matter up, because I thought he would be out of that room, and he was, but the teacher was promoted to the next grade, and so he had the same teacher again this winter. The same trouble started and was going on; I was getting complaints, and I told him finally that the next time he was kept in and punished at school, I would punish him at home. A short while after that he was punished at school, and I punished him at home. About a week afterwards I asked him how he was getting along. "Well," he said, "I tell you that teacher is doing better than she was last winter." I think, from the experience of a salesman, that every day I am looking out for the economical interests of the railroads, and every man that I run up against is doing the same thing; every official is very deeply interested in saving, and they want to be shown that I have got something that is economical. Sometimes we can show them and sometimes we cannot. They are very careful and every thought seems to be economy, economy, and my experience teaches me that they are after the strictest kind of economy.

MR. BARNUM: Mr. President, I would like to take exceptions to the views advanced by the writer of the article, that railroad men ignore the matter of economy. It has been my observation that fully 50 per cent, if not more, of most railroad men's time is taken up figuring on economies. Their views differ as to the means of obtaining those economies, and the views that were generally accepted by the best railroad men as productive of economy a few years ago have been modified, and are still changing, so that what we now consider economical practice may be cast aside for new and better practice, based on more experience, five years from now.

It seems to me that, if a Bureau of Economies were established, it would be more difficult than the writer thinks to select the right kind

of a man for the head. I believe the man who could properly manage those economies would very soon be a railroad president, and the matter of handling the labor question is one which would trouble that bureau of economies more than getting their statistics together.

In meeting committees of shopmen, including blacksmiths, boilermakers, machinists, carmen, and engineers and firemen during the past year, it has been my observation that those men bring up some very shrewd arguments to support their claims for more pay, or being relieved from certain duties and other concessions which mean increased expense to the railroad companies, and that in order to offset those arguments and show them that they are unreasonable, and the reasons why they cannot fairly be granted, one has to be thoroughly well acquainted with their line of work. That knowledge he cannot obtain from passing through a shop, from occasionally riding on a locomotive or from reading articles, no matter how well written, on the subject. He must know from his own observation and personal experience the points which are brought up, and be in position to either accept or refute them, as the case may call for. I was able to successfully refute the arguments of our boilermakers during the past summer for a larger rate of pay than we gave to our machinists and blacksmiths, for the reason that I knew that their arguments were not well founded, and I succeeded in showing them so, and they dropped the question.

The matter of economy, as I said before, is taking up the time and the thought of our railroad men to a very large extent, and it is not one which is by any means ignored, but there are differences of opinion as to how best to produce economies. In my opinion, the economy which is produced by thoroughly competent foremen is one which receives too little consideration, and the value of such foremen is underrated. I had a very excellent example of this a few years ago, in the case of a blacksmith foreman.

We had a man in charge of a shop with about twenty fires who, in his day, was considered a first-class foreman, thoroughly up-to-date, and his judgment was not questioned on matters in his department. But time passed and he stood still, and I, coming in as a new man, could see that he was behind the times, and in talking with him and making suggestions, found that he was so thoroughly imbued with his own perfection that he had reached a point where he could not be brought up to the times. I made the claim to my superior officers that I could save $500 a month by making a change in foremen, and in due time the change was made, and after the new foreman (who was a man of large experience and strong personality who, while he held every one of his men to an honest day's work, still gave them fair consideration), had been in charge for about three months, when I made a review of the improvements which he had effected, and I could figure out very quickly $1,300 a month which he had saved in salaries and wages, with an increase in the work turned out of the shop, and that of a better quality than under the old foreman.

Another economy which I think railroads overlook more often than private corporations, is that of providing sufficient supervision of work. The majority of railroad men who are advanced to positions of responsibility have not sufficient time to sit down occasionally and take a deliberate survey of the general situation in their departments, and the result is, that while they are driving away at matters which are urgent and to which they are absolutely compelled to give first attention, they do overlook economies which might be effected if they had sufficient expert help to relieve them of some of the details which they now have to handle in person.

Still another line of economies which, in the mechanical department, I find is very frequently underrated, is the use of up-to-date tools in the shops. I wrote for this club an article about two years ago on that subject, and the arguments which I presented at that time in favor of up-to-date tools have, since that time, been more and more impressed upon my mind, and I feel that if that article were now to be rewritten, I could say with more force and elaboration the things that I then said, and add to them sufficiently to make them more convincing.

That economy which calls for an expenditure of money is the hardest kind of economy to put into effect on most railroads, but my experience has been that if the case is properly presented to the higher officials, who are responsible for the operation of the road, and suitable arguments can be brought to bear to show that his knowledge of the subject is correct, and that the saving to be effected by the expenditure will result in greater economy, that in most cases he will be successful in obtaining the expenditure desired.

MR. G. T. NEUBERT (K. C. Belt Ry.): Mr. President, I believe the object of the writer is to outline an extreme in order that it might be discussed, and by so doing arrive at the truth. Many times we say things to bring out facts and set one to thinking, and this seems to be the case in the paper presented.

The communication from Mr. Scott is a very able article and one which does justice to all those who have charge of railroads. While they may be working on a salary, it is not altogether a question of salary; their reputation and entire future is at stake, regardless of their employer, or the railroad company for which they are working. I believe we all understand that.

I notice on page 2 the writer designates the superintendent or next official in authority, as chairman of this bureau. After they have made the necessary investigations and submitted the results to the head of the department under investigation, they are also expected to present a report to the general manager, to whom the official is answerable for action taken upon the bureau's recommendation. It seems to me this would bring about quite a disturbing element on the lines suggested, and in time become obnoxious. We all take pride in trying to excel and vie with one another regarding the best methods and the cheapest man-

ner of operation. It would be better to furnish the official with sufficient force to enable him to keep proper records and secure statistics that will enable him to be in a better position to economize.

MR. D. VAN ALSTYNE: It seems to me I would change Mr. Waggoner's bureau to one of execution. The difficulty does not lie so much in the inability to discover possible economies as in the inability to carry them out. The efficiency of an engine is measured by dividing the energy we get out of it by the amount we put into it. If the efficiency of be very high, but probably it is as high as in any large business insti-railroad operation is measured by the actual value of the labor and material gotten out of it divided by the value put into it, it would not tution. Measuring the efficiency of the mechanical department in the same way I should say we get about 75 per cent of what we should reasonably expect to get. The natural efficiency of the average man is not high, and the ordinary railroad organization does not provide means to materially increase it, so that the efficiency of the whole is practically the natural efficiency of the individual.

What is needed is closer attention to the individual, not only to educate him to increase the quantity and quality of his output, but also, and of still greater importance, to provide means of following him up to see that he produces to the extent his education enables him to.

MR. A. L. HUMPHREY (Westinghouse Air Brake Co.): It occurs to me that Mr. Wagoner has omitted entirely one very essential point in his paper, viz., who is to determine what is meant by the word Economy. We have all known what would be considered, as compared to the practices of other roads, the height of extravagance. I would like to ask if this Board or Bureau would, for instance, decide on the number of ties that should be removed from the track annually? Would they have the say as to whether a tie that has run four years for instance, and is becoming decomposed, should be removed, or would this be left to the judgment of the road masters or track men? Would it be for them to say that ties should remain in the track another year or two, thereby be like the General Manager who made a report to his Board of Directors some few years ago, wherein he claimed he had brought about a saving to their property of a great many dollars by turning the ties and replacing them by removing the ties, turning them up side down and replacing them in the track so as to get longer service out of them? Is this the line of economy that the Bureau would be supposed to handle? On the other hand would it be for the members of this Bureau to enter the fireboxes of the locomotives, inspect them and instruct the foreman Boilermaker not to remove a certain fire box but to permit it to run another year? Would it be up to them to order engines out of the shops because of the delays to trains, thereby perhaps causing engine failures which would in the long run increase the cost of transportation? Railroad companies have one commodity to sell—that is, the commodity of transportation. The more they can make out of this transportation

the more successful they are and the more the officials are thought of in railway circles.

If by putting their road bed up to the highest standard, spending money to get modern equipment, thereby reducing the dead haul of their cars by increasing the ratio of load to the dead weight of the car, if by being what appears perhaps extravagance to some, they can reduce the cost of transportation by showing decided reductions in the cost of hauling a ton of freight one mile or hauling a passenger train per mile, is this not economy and would this Board be supposed to supersede the board of directors and higher officials in passing on matters of this kind? The same argument that is produced by the writer of this paper would apply to our army and navy. I hardly think that he would suggest for a moment that it should be necessary to give the soldiers of our army government bonds in order to make them interested in our government and in order to produce better officers in the army and navy. It is an acknowledged fact that the most successfully operated institutions in the world are those governed entirely by those not personally interested. It has been my experience, and I believe is borne out by facts and statistics, that railroads are as economically operated as any institution in the country and from the experience that I have had with railroad officials I believe that the same amount of energy that is exercised by railroad officials in this country if put forth in any private enterprise would bring results much more remunerative than is the general average in railroad circles.

MR. PETER H. PECK (Chicago & Western Indiana R. R.): I have always thought that a railroad man ought to be economical if he is not, for the first thing he hears when he commences railroading, is economy. Beginning over thirty years ago, when I first commenced railroading, I have heard nothing but economy. When I was firing, they were after the firemen for burning too much wood, and when they got the coal burning engines, they were still after the firemen for burning too much coal. When promoted to an engineer, economy was still after me on account of running repairs, using too much oil and things of that kind. It was economy, economy all the time. I do not know where there is a superintendent of motive power who does not get some points in economy every month of his life, and especially when the pay rolls come in. In fact we know and hear nothing else but economy all the time. The master mechanic will pick up a bolt in the yard and carry it to the blacksmith shop and have it made into a shorter one in order not to have that piece of iron go to the scrap pile. The only difference in railroading nowadays is, the master mechanic, or the superintendent of motive power has more items of economy to look after than they formerly did; that is, they give him more to look after; thereby they do not economize in his duties. I remember when I first went railroading the master mechanic on that road had ten engines to look after and twelve stalls in the round house. That was all the power on that road at the time. They had a master car builder and about 300 cars. They also had a man to look after

the water tanks, and only had nine on the road. The master mechanic of today would not know what to do with himself if he only had ten engines and 300 cars to look after. In olden times they had a man at the head of every department, but nowadays the master mechanic looks after over 7,000 engines and 100,000 cars, and it is economy all the time. That is what he hears in the day time and dreams of it at night.

MR. E. R. WEBB (Mich. Central R. R.): I have read very attentively the paper by Mr. Waggoner, and I have also listened very attentively to the remarks made by Professor Goss, Mr. Humphrey, Mr. Peck, and others, and I will say that I believe, without any exception of any statement, that Mr. Waggoner is wrong. Mr. Peck puts it very plainly; economy is the word from the time when you first enter the service, and I will say that, although what you might term a novice in division management, that is, in conducting affairs, that economy is everything. With all our monthly statements compared with hours of work to the previous month's statement, we have a comparative statement for everything. I cannot see where Mr. Waggoner could get such a low estimate of men. I will leave it to any fair minded man if his salary is all that he works for. Is there no spirit of excellence in men? I believe there is. The average man does not get salary enough perhaps, yet it is what he is working for, and aside from that, and greater than that, is the spirit to excel, his spirit of pride, his spirit of faithfulness to his duties. While perhaps there are some of us who do not lie awake nights looking for economies—we have got to have a little sleep—yet that spirit predominates. There is not any man who has his work at heart who can separate himself from those duties as he goes home; he thinks of them; he is concerned about them. Even when I am not responsible, yet I am concerned, and I do not believe that I am one in a great many thousands of railroad men.

PRESIDENT CRAWFORD: Is there any further discussion? If not, we will ask Mr. Waggoner to make his closing remarks.

MR. WAGGONER: Gentlemen, what I might call the only unfortunate part of the paper seems to be my remarks in regard to the interest of salaried men in their work. Now, when I had that in mind I was not thinking of the superintendent of motive power, or men of that class at all, because I was associated with that class of men altogether too long to take that view of them, but I was thinking of minor officials, and from my experience around through the shops—and I have followed up the shop accounts from the material when it came off the car, into the storeroom, the labor from the time it entered into the shop until it was accounted for in the auditor's office, followed up the whole line of work all the way through in the equipment department, and I have seen instances, among minor officials where they did not care a rap for expenses. I have heard a foreman use the expression, "What do I care, it is nothing to me." It is the same way with many of the men. I have seen material wasted, right under the foreman's eyes, who did not bother about it, and the master mechanic cannot be everywhere.

To cite an instance or two: In looking up some expense items at an outlying shop that did considerable light repairs to engines and cars, I had occasion to speak to the foreman about the cost of some repairs, to which he replied, "I can't look after expenses; I have all I can do to keep the place running. Besides, it is nothing to me what things cost, anyhow." Now he was a good man, but he simply didn't think that it was necessarily a part of his work. It is not railroads alone, this policy. It is everywhere. I had a personal experience of this recently while on an engineer corps constructing an electric railway. If the engineer in charge had not kept hammering after expenses I doubt if any of us would have thought much about the cost of things, we were so busy pushing the work.

At one time we found considerable discrepancies in the cost of work in the blacksmith shop. The foreman was expected to report all material used to the storekeeper, as the iron works were alongside the smith shop, but he thought this too much trouble, and to use his own words, "You expect every foreman to be a clerk, too, do you? What is the difference so long as it was used for the company?" But he had to look for another job. I was in the tin shop one day, which was in isolated frame building back of the roundhouse. A fireman came in with a leaking gallon can filled with lard oil, and asked the foreman to have it mended. He said, "We can't fix that with oil in the can; go empty it." The fireman went outside the door and emptied the oil on the ground and brought the can in empty to be mended. It was nothing to the foreman or to the fireman; it wasn't their oil.

I saw a multiple drill running very slowly and I asked the man at the work why he didn't speed it up. He said it was running fast enough for him, and on speaking to the foreman, with whom I was friendly, he said I am not looking for trouble. As I wasn't looking for it either at that time, I kept my observations to myself, but piece work soon remedied a great deal of this sort of trouble, if it did bring some of another kind. At this same shop they were carrying a quarter of a million dollars in shop supplies and materials. Later, when the subject of the amount of materials carried was thoroughly investigated and steps taken to reduce stock on hand, the material account was reduced to $75,000, and the shops turned out more work than before.

Now, I will reply to other points as they come to my mind. I now take Mr. Peck's statements about economies. We thought we were doing just as well as we could in the lubrication of freight cars. We had gone all over the subject and hammered everybody right and left: we made a contract with the Galena Oil Company, and what did they do? They cut the consumption in two, yes, less than in two, and the cars were just as well lubricated as they were before. Now, why didn't we do it? Because we never looked after it in the way they did. We didn't know how. I will admit that we didn't know much except "economy." That is the general manager's business, to hammer into the heads of everybody that they must economize. I was in the motive power department

long enough to know what the general manager was doing all the time. This is not a new subject to me. This idea has been talked over with railroad officials. Mr. Soule knew what he was talking about in regard to the Pennsylvania Lines, and they might have adopted some system on the Pennsylvania Line had Mr. Edward B. Wall lived, not possibly like this, as this is simply the figment of a man's brain and something to get started on. You have got to put down something to talk about, and I remember the laughing remark of one gentleman who said, "Well, we will have that bureau organized in heaven, among the angels, to have it handled properly; it can never be done on earth." That is the trend of Mr. Scott's extreme remarks; he is talking about the millennium coming, starting with a bureau fully organized to accomplish everything, but that is impossible, and we all know it. Enough has already been said here by the railroad officials, a superintendent of motive power and others that are officials who have not the time to go after the economies that they see around them. I made that statement in the paper. The fact of the matter is, that is the position I have taken all the time; the fact that railroad officials know these things, but they have not the time to go after them. If you have ever been in a busy office of a big railroad, where all you can possibly do is to get through and keep things moving, and the only time you had to think about economies was at night, why, then you would realize that there was a chance for economies in railroad operation.

I have made the statement to a number of higher officials that railroads were the most expensively operated organizations in the world, and that was the general feeling among the higher officials, and that is the reason why they hammered us to make more efforts in economy. They realized that there was room for improvement.

Now, as to how this bureau would work, no one can tell exactly how it would work or what it could do. It is only the idea that railroad officials should have some kind of assistance in hunting up the points where economies could be introduced, and I think Mr. Soule's idea of different bureaus is better than mine. Economies should be looked for everywhere. It might be well to look into the legal department, as Mr. Scott has suggested. I think in a great many cases the legal department is pretty expensively administered. I have no personal feeling in this matter, and it is no pet idea of mine, it is simply that in past years this has been talked about; in fact, there is one large system in the United States today that has this idea under consideration, not as I have outlined, but an outside body of some kind, to co-operate with the department heads on the subject of economy in their departments. How it will work out, nobody knows. Now, it takes a man who is pretty nearly an angel that is able to co-operate and advise without interfering. I had such a man in mind when I wrote this paper, on the Pennsylvania Lines. I knew one who was a splendid man to investigate anything, a man that everybody liked and that could work with anybody and everybody, but I think he would make a very poor general manager. However,

I want to say that I believe there are such men; I believe the thing can be done, but that I know just how to do it, why, that I do not claim. There has been enough said on this floor, I believe, to substantiate the basis on which the paper was written, and that is, that railroad officials could be assisted through an outside force, or some element or bureau that could assist them in getting after economies. Take it on the Pennsylvania Lines where they have officer's organizations, virtually a bureau with sub-committees, investigating all sorts of things in quest of economies. How do they accomplish so much? Simply, they co-operate for the desired end. I know of the co-operation that was done on the lines there during the hard times, when we organized ourselves, it might be said, into such a bureau of economy. We had the time and not much else to do. I never worked harder in my life than during those times in making up tables, going after statistics for general managers and officials, and it was found by comparisons that the shops were doing more work with fewer men, and shorter hours, than had been the case during prosperous times. I only say that there is something that can be done in economies, and that was the ground upon which the paper was written, and which was only a "suggestion," as noted in the title.

PRESIDENT CRAWFORD: If there is nothing further to come before the meeting, a motion to adjourn will be in order.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular monthly meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday, February 16, 1904; Mr. P. H. Peck, treasurer, in the chair. Meeting called to order at 2:30 p. m.

Among those present, the following registered:

Bement, A.	Harris, E. K.	Peck, P. H.
Bennett, F. F.	Hechler, W. D.	Pettis, C. H.
Bischoff, G. A.	Hodson, Wm.	Raidler, W. P.
Brandt, F. W.	Hoover, E. E.	Robinson, Jay G.
Britenstein, J. F.	Jackson, Thomas	Sanborn, J. G.
Brooke, G. D.	Johnstone, H. C.	Scott, G. W.
Brooks, P. R.	Keeler, Sanford	Setchel, J. H.
Brown, J. M.	Kennedy, Chas.	Shantz, O. S.
Brown, R. L.	Linn, H. R.	Sherman, L. B.
Bryant, Geo. H.	Long, J. H.	Smith, F. E.
Bryant, W. E.	McCarthy, J. J.	Smith, R. D.
Cushing, Geo. W.	Midgley, S. W.	Talmage, J. G.
Coates, H. H.	Mills, Geo. F.	Thurnauer, Gustav
Cooke, W. J.	Nicholl, G. P.	Tratman, E. E. R.
Cross, C. W.	Noble, L. C.	Vissering, Harry
Crossman, W. D.	Otley, Benj.	Waggoner, W. B.
Fry, Jr., C. H.	Owen, Elmo	Willsie, A. N.
Furry, Frank W.	Parker, W. R.	Wilson, G. L.

THE CHAIRMAN: First in order will be approval of minutes as already printed, and they will stand approved if there are no objections. There being none, it is so ordered.

The Secretary presented membership statement as follows:

Membership, January, 1904	1,083
Dropped, account mail returned	1
Withdrawals	11
	1,071
New members	7
Total	1,078

NAME.	OCCUPATION AND ADDRESS.	PROPOSED BY.
John D. Ristine,	Lowe Brothers Co., Dayton, Ohio	J. W. Taylor.
Robt. D. Stearns,	Northwestern Elev. R. R. Co., Chicago	J. S. Thompson.
G. R. Brandon,	General Engineer, Whiting Fdy. Equip. Co., Harvey, Illinois	J. W. Taylor.
Joseph E. Gould,	M. M., C. H. & D. Ry. Co., Lima Ohio	C. H. Cory.
Wm. Hodson,	Crosby Steam Gage & Valve Co., Chicago	Chas. G. Ludlow.
Mark A. Ross,	Mgr., Pyle Natl. Elec. Headlight Co., Chicago	F. W. Furry.
J. L. Replogle,	Supt. Forge & Axle Dept., Cambria Steel Co,, Johnstown, Pa.	W. S. Templeton.

THE SECRETARY: Mr. Chairman, at the meeting of the Board of Directors this morning, the following committee was named on Revision of Rules of Interchange, to make report at our April meeting: C. A. Schroyer, Jos. Buker, H. B. La Rue, C. M. Mileham and Chas. G. Deen.

These gentlemen should have their report on the revision of rules ready for our April meeting, so that it can be discussed and modified as the Club wishes and forwarded to the Arbitration Committee. The Arbitration Committee probably will meet early in May.

THE CHAIRMAN: The first paper this afternoon will be "Square Roundhouses," by Mr. George P. Nichols, which will be illustrated.

MR. GEORGE P. NICHOLS: Mr. Chairman and Members of the Western Railway Club, Gentlemen:—I wish to apologize to the Club for the incomplete form in which I am offering this paper, and in explanation will say that I have been absent from the city for over a month, returning just in time to appear before you, and as I promised Mr. Taylor that I would have this paper ready for this meeting, I have decided it is best to present it as it stands rather than to disappoint him. The particular omission is the estimate of the cost which I intended to include, but which the shortness of time has made impossible to prepare, but I will submit this later for publication if desired.

In presenting this paper I wish it understood that I do not claim to have more than a general knowledge of engine house construction and operation; but recently while in conversation with Mr. H. E. Vautelet, former assistant chief engineer of the Canadian Pacific Ry., he spoke of the use of the square form of engine houses in France and England, which so interested me that I afterward made some studies of the design, and at the suggestion of several of our members, I decided to put it in the form of a paper to present to you, leaving it for you to decide as to its merit. The paper is as follows:

SQUARE ROUNDHOUSES.

By Mr. Geo. P. Nichols.

I have intentionally selected the subject as the Square Roundhouse, for the reason, that so far as I know, every engine house in this country, with one exception, is built on a circle, evidently for the reason that the design started with the turntable as the center, or basis, and practice has followed this fixed design. Just why it should have retained this old form while nearly every other form of building has been modified to meet changed conditions it is not quite easy to understand; but probably because the turntable has been considered to be the only feasible method of directing the engine to its stall with the greatest economy of labor. The transfer table has been in use for years, but has not been considered a feasible means of distributing engines to their desired places.

My object is to show up the disadvantages of the roundhouse form, and as against them to demonstrate the superiority of the square house. I shall take up the various points detail by detail so as to more thoroughly cover the whole; and for comparison I shall treat with a fifty stall house, taking the design of a roundhouse just approaching completion and designed by the best talent, having the advantages of experience up to date, as the basis.

Plate 1 illustrates the ground plan of a roundhouse which covers the complete circle. In the center is the 75-foot turntable; then a space of 90 feet between the turntable and the inside wall of the house, all exposed to the weather. Each stall is provided with a double door, wood frame construction, making 100 single doors, which the conditions of engine house service requires, several being left open at all times—and then the question is, why is it so difficult and so expensive to heat the house properly. A snow storm occurs; and the doors swinging out, it is imperative that the snow be cleaned away and carried outside of the house, involving no small delay and expense, particularly in cleaning the turntable pit. Then did any one of you ever see a house of any size but what several of the doors were badly broken, requiring constant repairs? And how many more are badly fitted and stick when being opened.

Entering the stalls—they are narrow at the entrance and wide at the extreme end, the average desired width being at the center—an extravagant use of valuable space.

The details of the pit itself need not be considered, as that feature alone remains unaffected and in either case can be built in accordance with modern practice, including as many drop pits as are desired.

You have filled your fifty-stall roundhouse and the demand comes for additional motive power; one, two, three, six or more additional

engines; now, what are you going to do about it? You will have to build a distinct house to accommodate these engines, put in another turntable and start all over again, often-times with the great disadvantage of not having any available space to locate it, and a small capacity roundhouse is but a poor affair and extravagant by requiring additional labor.

Plate 2 shows the plan view of a fifty stall engine house built on the square principle. This consists of four walls and the entire space covered by a roof of economical design. Through the center, longitudinally, from end to end, runs a 70-foot transfer table with twenty-five

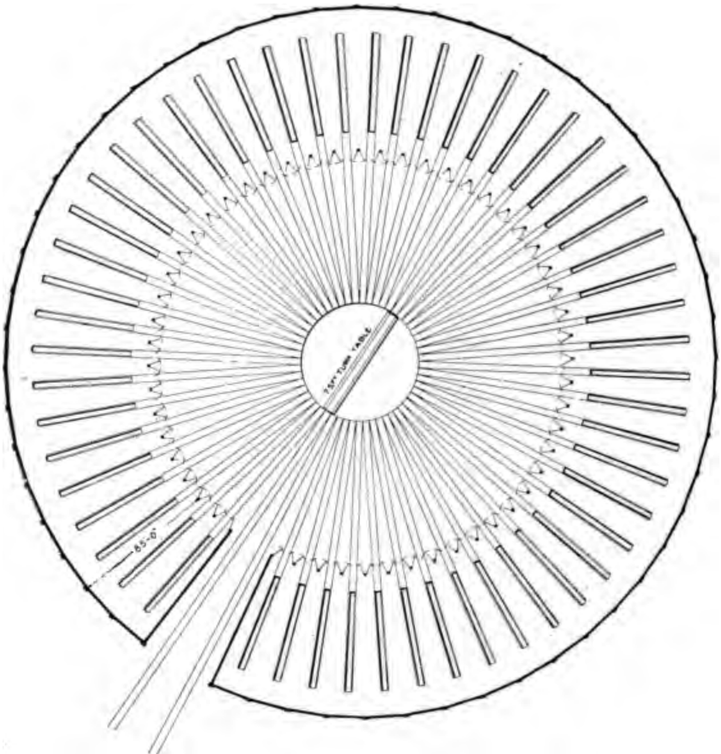

PLATE 1.

stalls on each side, rectangular in shape and economical in the use of floor space. The end of the stall begins with the end of the table with no waste space; the pits are the same as in the roundhouse with no departure from regular roundhouse practices. The entrance is at one side of the building through one door which can be of the steel roller type, which is not usual with the roundhouse on account of its great expense, or wood door swinging in or sliding, as may be desired, which is not affected by the snow. The building being completely roofed over, work is not delayed by snow or rain. It is unnecessary for me to

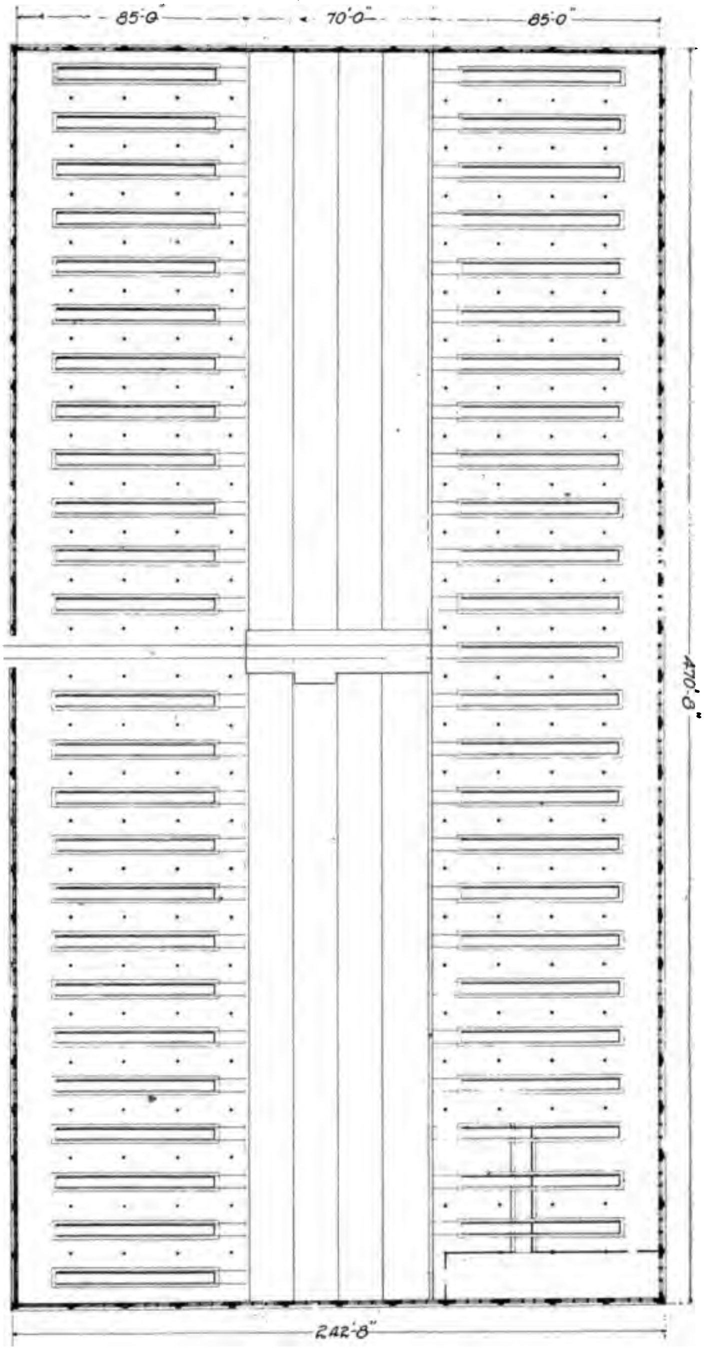

PLATE 2.

state what a difference there will be in the heating problem with one door, as against fifty. An engine enters the house, either under its own steam, or, if dead, it is hauled on to the transfer table by the winding drum cable, then it is moved longitudinally and placed in the desired stall in the same manner—either by its own steam or the winding drum. As the table will have to travel only half the length of the house to reach the extreme end stalls, the speed of the table can be made nearly equal to the speed of the rotation of a roundhouse turntable, so practically no time is lost in this method.

Now, please, compare the ground space required by the square house as against that of the round house. The latter requires about 50 per cent more than the square form.

One, two, four, six,—any number of additional engines are delivered to you to be served by this house. You simply take down the section of the wall at either end of the transfer table pit and rebuild the entire end wall at the desired distance, extend your transfer table pit, and you are ready for service.

For quick repairs such as your recent shortage of motive power has imposed upon you, there is nothing more economical than an electric traveling crane, and one or two stalls, to be selected by you, can be covered by a crane of moderate capacity supplementary to your drop-pit, the form of building construction reducing the cost to a minimum.

The conditions of light remain about the same, as the windows in the side walls and the lanterns in the roof should admit ample light. The smoke stacks will remain the same.

You will naturally say this design leaves you without means of turning an engine, which is true, and a turntable must necessarily be provided at some convenient point outside of the house unless the conditions will admit of the use of a "Y" or some other means best known to you. While I have never attempted such a device, it has occurred to me that it be feasible to design the transfer table so that the frame will rotate on a traveling base, thus making it a combined transfer table and turntable, the only apparent objection being the increased depth of the pit necessary for such a device, and I shall, in the near future, design such a combination. You will also criticise the provision of a single entrance, and that placed in the center of the building, but the design is perfectly flexible in this direction and one or more entrances can be provided wherever desired or the conditions require.

Regarding the reliability of the electric transfer table as compared with the turntable, will say, with the experience of building a large number of transfer tables used in all parts of the country and under every conceivable condition, that I have found it to be equally as reliable as the turntable. As a matter of precaution a hand attachment can be provided, which, however, I do not consider necessary. Should an extra precaution be deemed desirable, a second table can be provided to run in the same pit, which, of course, would increase the cost. Incidentally, I will state, that the speed of a transfer table when loaded

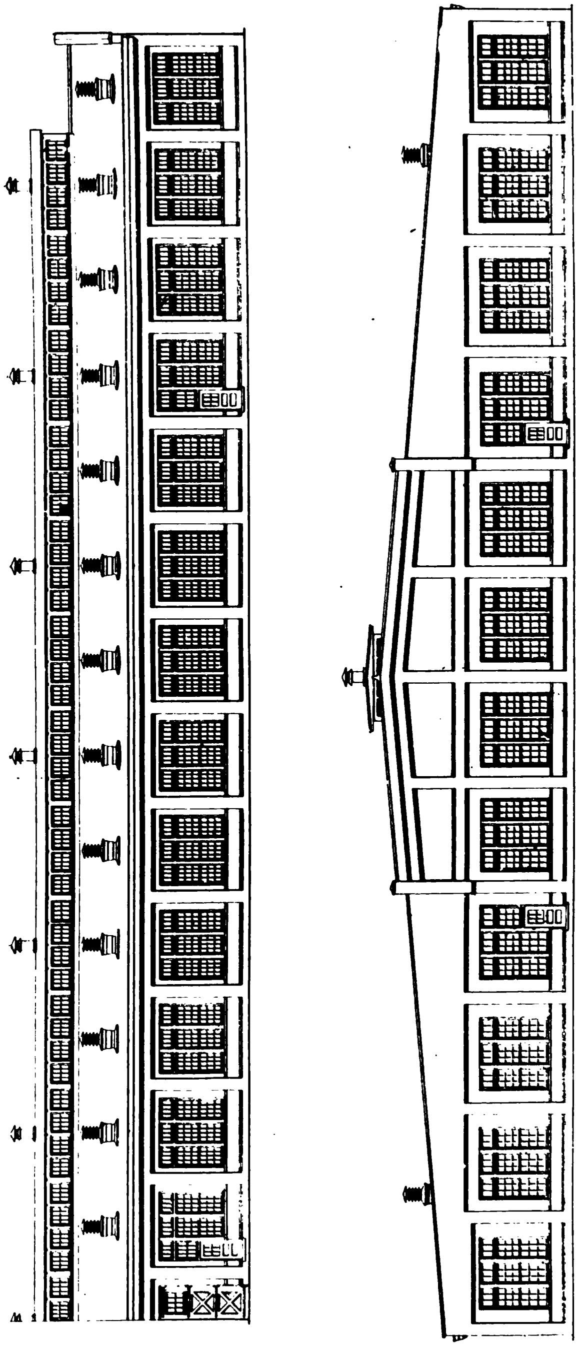

PLATE 3.

with a standard engine ready for the run can be between 125 feet and 250 feet per minute, and with the high speed gear thrown in for moving the table when empty, the speed can be at least doubled; and I can mention a case where one of the largest tables built runs at a speed of 800 feet a minute when empty or with a light load.

The nearest approach to this square form of engine house which I can mention is the arrangement recently adopted by the Terminal R. R. Assn. of St. Louis for handling all their engines near the entrance of their station. In this case, three square engine houses with tracks running lengthwise through the three are provided, with a transfer table pit between each of the two houses, in which are two 75-foot, 150-ton electric transfer tables, and as this is probably one of the busiest engine houses in the country, you will appreciate the confidence placed in the electric transfer table for reliable service.

For illustration I will show photographs of such a transfer table as will be required for this service, and also photographs of a roundhouse with a 75-foot turntable operated by an electric motor.

THE CHAIRMAN: Gentlemen, the paper is now open for discussion. We would like to hear from you in regard to square roundhouses.

MR. C. A. SELEY (C. R. I. & P. Ry.): There is only one thing that occurs to me. I notice the author stated that he had been unable to present figures at this time. I hope that Mr. Taylor will induce him to prepare these figures and incorporate them with the printed report of the paper. I think they will be of extreme interest.

MR. NICHOLS: I will say that I have made a rough estimate of the cost of the house complete, with the transfer table, but without drop pits, crane or heating apparatus, at about $1,700 per stall. I am not sure that this is correct, but it is reasonably close.

THE CHAIRMAN: Mr. Forsyth, you have had experience with roundhouses, both in this country and other countries. Will you give us some of your ideas on the subject?

MR. WILLIAM FORSYTH (Railway Age): Mr. Chairman, this plan of Mr. Nichols is so novel, in this country at least, and he has worked it out in such good shape, that I hope some railroad will take it up, so that American roads will get some experience with rectangular roundhouses. It is the prevailing plan abroad; most engine houses in Europe are rectangular in form and use transfer tables. I am sorry that Mr. Nichols did not show some plan of turning locomotives by means of a "Y", which I think he suggested in connection with the rectangular house, because it would affect, to a large extent, the general plan of the shops where they are combined with the roundhouse. I thought at first there would be quite an advantage in this one feature, at least, of the rectangular house; that is, the value it would have in fitting in symmetrically with rectangular buildings in the shop scheme, but if the method of turning the engine requires circular or Y-shaped tracks, it would, to some extent, interfere with the compact assembling of such a house with the shops.

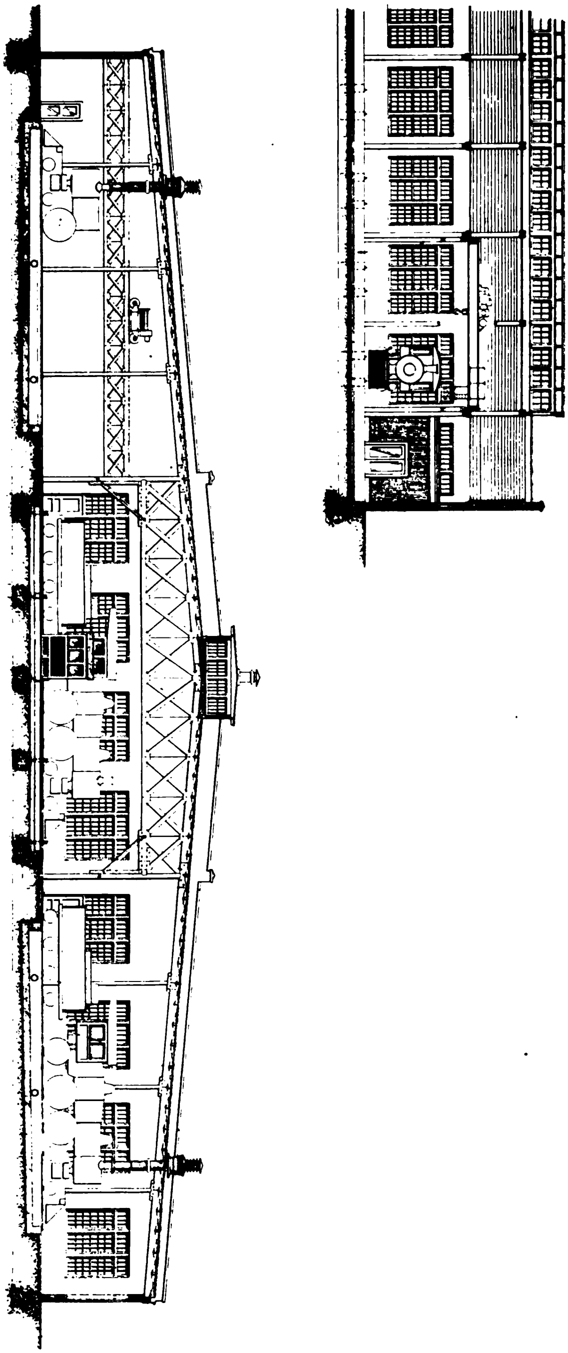

PLATE 4.

In designing the cross section of the shop with the crane, it would appear to me that the height was not sufficient to lift the locomotive off its wheels. I do not know whether Mr. Nichols considered that for an engine with large wheels or not, but if a railroad went to the expense of having a traveling crane in an engine house, it might as well make it of sufficient capacity for that work.

I recently visited a shop where they found it a convenient thing to send engines to the erecting shop from the roundhouses, and have them lifted off their wheels there by the overhead crane, and attend to work of that kind there rather than to attempt to drop the wheels in the roundhouse, so that I think that that part of the plan is very good in having a traveling crane which could be worked in so easily in a rectangular engine house. For my part, I rather look favorably upon this plan. As I say, I hope some railroads will take it up.

THE CHAIRMAN: One thing strikes me very favorably after this severe winter, and that is, that it is all covered so that there will be no snow to contend with. There is a great expense in some of our roundhouses in getting rid of the snow, loading it on the cars, etc.

MR. WILLARD A. SMITH: How would it affect it in the summer with smoke and gas?

THE CHAIRMAN: I should think you could regulate that by ventilation.

MR. E. E. R. TRATMAN (Engineering News): It seems to me that this idea of Mr. Nichols is a very good one. It puts into the roundhouse, or into the engine house, a system very similar to that which we have been using for a great many years in erecting shops, but instead of having an overhead crane, it has a transfer table for serving the pits. Transfer tables have been used for years in handling engines and large cars in shops, and we know pretty well what they will do. They are reliable and efficient in that work and should be equally so in the engine house. As to the arrangement of the other parts of the yard to connect with the engine house, I should judge that in planning almost any extensive series of shops or large yards it would be very much easier to work in a rectangular engine house than a circular one. A 50-stall roundhouse with 80-foot stalls, 80-foot space between the house and turntable, and a 70-foot turntable, 309 feet diameter in all, will cover 120,000 square feet. A 50-stall rectangular house, with two rows of 80-foot stalls and a 70-foot transfer table, making a house 375x230 feet, will cover 86,250 square feet. But in addition to occupying less space the rectangular—or square—house will fit in better into the general plan of the yard.

In Europe the usual plan is to use these square houses, with tracks running through the long way; they get sometimes five engines in a row. It looks as though that might make it awkward to get at the middle cars, but they claim that by care in placing them, they get them so arranged that there is very little extra handling of the engines.

The Lehigh Valley Ry., some years ago, had several square roundhouses with the tracks through them the short way, approached by a ladder track leading up to the house, and then a series of six or eight tracks running straight into the house. I think their largest one had nine tracks, each track holding two engines, at the head of the engine house. The great advantage, it seems to me, of Mr. Nichols' plan is that he simply adopts the pit system of handling his engines all inside of the house. It must be a great economy in space, and the approaches would be very simple.

One thing I would like to see would be a fireproof construction. The drawing shows a timber trussed roof and a timber truss for the crane, but in case of a fire, in a house like that, all the engines, or at least a good many of them, might be destroyed before they could be got out. I think in these days, when we are putting so much fire-proof construction into shops, that a fire-proof roundhouse ought to be considered. I noticed at the new Moline shops of the Rock Island Ry., where they have steel and brick buildings for all the shops, the roundhouse is of frame construction; that is, it has one or two rows of wooden posts and a wooden roof construction. It seems to me it would be very much better to use fire-proof construction in an engine house.

MR. NICHOLS: I touched on that point in the paper as it appealed to me in working out the design, and I intend very soon to design a combination of a transfer table and a turntable, by providing a traveling frame of proper proportions for carrying the center and circular track for the turntable, which, probably, will be of a standard form. I think this will work out very nicely so far as the combination is concerned, the only apparent objection being the depth of the pit required, which, of course, must be sufficient for the frame and the added depth of the turntable girders. Possibly, this objection may be off-set by the advantage of having a turntable in the house without requiring greater space than the transfer table would occupy.

MR. GEORGE WELSBY SCOTT: The paper which we have heard read has been so well presented, and so well illustrated, as to cause me to think that Mr. Nichols has left us very little to talk about, except to approve and commend. There is one point, however, that has been touched upon in this discussion, and that is the facilities to be employed with respect to turning engines. Mr. Nichols is seemingly inclined to consider a combination turntable and transfer table; and if I understand him correctly he would have the upper part of the combination to contain the turntable, which table would also act as the bridge over which engines would be passed from the one side of the transfer pit to the other, and the lower part of the combination would be that to which the propelling mechanism would be applied.

Combination machines, at best, are unsatisfactory devices, clumsy and cumbersome, and sadly inefficient generally. Mr. Nichols, however, may have some specially good arrangement in mind; but I am

inclined to think that when he takes up the work of designing this combination transfer and turntable he will find a real difficulty. The proper design of a 70-foot transfer table competent to handle heavy locomotives is no small problem in itself, and the difficulty will be found when an attempt is made to impose upon this another structure of the character of a turntable.

A transfer pit if only 24 inches deep offers objections enough seeing that from the very nature of the case men have got to pass from one side to the other; and how would it be in the case of this combination machine with its super-imposed turntable, the whole, probably, entailing a depth of 6 feet or more? It would seem to me that the best course to pursue, if a turntable is desired in this suggested order of things, would be to have the turntable apart from the transfer table, even if this resulted in the necessity of having a separate and special space reserved for it in the square roundhouse.

In a final analysis of this point it may be found that the best course to pursue would be the adoption of the "Y" as a means for turning engines. A "Y" for this purpose need not be at all expensive, nor need it occupy much space. Furthermore, in its position near the roundhouse or engine house the space within the "Y" could be advantageously used with respect to storage of coal, or for any other desirable purpose.

MR. SELEY: I agree with the last speaker about the combination of the two features. I do not think it feasible on account of the concentrated weight on the center carriage, the track and its foundation.

MR. P. H. BROOKS (C., B. & Q. Ry.): I am right in the midst of combating the cold weather siege at an important roundhouse and this plan has a great many advantages, as well as disadvantages. In the winter of course, it is a great advantage, as the chairman has said, to have the transfer table under roof, because the difficulty with snow and ice is something surprising, but in the summer the heat, gas and smoke is equally troublesome. The cost incident to having the additional space under roof, which is only used in the traveling of the table and which is unavailable for any storage of material and used by the workmen crossing the house from side to side, must be considered. In stepping across the house from side to side, this design of a house would be a much less man-killing job to oversee and oversee properly, because the space to be traveled by the foreman and men will be reduced one-half, and although it will be necessary to cross it back and forth, that will be quicker than racing around the house. Also, the proposition of light is much more easily solved.

The mechanical proposition of putting the turntable upon the transfer table is one that I am afraid could not be solved very handily. Take the engines under the various conditions, when they will not balance, and it might be quite a problem to get them turned without tipping over the table.

The crane and drop pit, in my estimation, depend largely on how much in the line of machine tools we have available for service at the

roundhouse, because there is small use for a large and expensive drop pit if we are so arranged that all we can do is to take the wheels out, load them up and send them to the nearest shop. We would have a semi-barren space unless we have machine tools at hand that require the overhead crane. It is a very handy thing for many jobs on modern massive engines, but it would not seem to be justified unless we had sufficient equipment at hand which the crane would also serve. Really the machine shop should also be served by the overhead crane directly in connection with the drop pits in order to make that a paying feature of the plan. However, local conditions might make either a very acceptable feature, singly, in many roundhouses.

The general design seems to have very much more in it to commend than to condemn, and the fireproof construction is also a very good point to be made.

THE CHAIRMAN: Has anyone else any discussion on this subject? If there is nothing more to say, Mr. Nichols, will you kindly close the discussion of your paper?

MR. NICHOLS: I will state that I had in mind the use of fireproof construction, and it is my idea to get estimates on the cost.

Answering the question about the amount of dead space necessitated by the transfer table, I find that the total area required by the square form on the basis of a 50-stall square house, as compared with a 50-stall roundhouse, is only about two-thirds. In other words, the round form takes exactly 50 per cent more space than the circular, so that as far as ground space is concerned, it is very economical.

THE CHAIRMAN: Next in order is the paper entitled "The Influence of Brain Power on Dividends," by Mr. A. Bement.

MR. BEMENT: It has been suggested as desirable that I present a few examples illustrating the application of the scheme suggested. Being an engineer, I will mention a few engineering problems.

The British admiralty has expended millions of pounds for Belleville boilers, and after some years the fact that they were an unsuitable device forced itself to the attention of the public. If studies of this boiler had been made, it would have appeared that it must be a failure for two reasons: one that it is made up of an immense number of screwed joints, which could not remain tight. The other that the water supply capacity of the tube element is not sufficient; each of these elements composed of from 7 to 10 sections of 6 feet in length and 4 inches in diameter, receives its water supply through an opening not to exceed 3 inches diameter. Thus the equivalent of a tube 42 to 60 feet in length is employed, with the result that the water is evaporated by the time it has traveled about 30 feet, resulting in the fifth section above the fire failing, due to overheating. These two faults, one a simple problem in mechanics and the other in physics, could have been easily discovered if the matter had been given study, and thus could a great mistake have been avoided.

A railroad problem, is that of shaking grates. Every locomotive is equipped with such device, but these grates are seldom shaken, and I do not believe anybody takes the trouble to thoroughly study the problem to find out whether it is well to shake them, what the effect would be, or what it will cost to do it, or why it should be done.

In my own work, a bad example of discharge of water, together with steam from water tube boilers, presented a case of serious trouble, requiring the expenditure of thousands of dollars for only a partial remedy, according to the best standard methods of treatment. A small amount of careful, yet simple study of the matter, resulted in the devising of a thoroughly effective remedy at an expense of hundreds of dollars. The paper is as follows:

THE INFLUENCE OF BRAIN POWER ON DIVIDENDS.

By A. Bement.

Some years ago Captain Mahan, U. S. N., wrote a book on The Influence of Sea-Power on History, in which he showed that the nation having the largest navy would exercise greatest influence on political history. At a recent meeting of the British Association for the Advancement of Science, Sir Norman Lockyer, following the idea of Captain Mahan, entitled his presidential address, The Influence of Brain-Power on History, the argument being that the nation best educated in science and business would lead in industrial achievement. He showed how in Germany governmental influence and assistance resulted in the production of a large class of well and soundly educated students equipped to deal with industrial problems. For this reason, and not owing to natural advantages, is Germany rapidly gaining in industrial importance, compared with Great Britain.

The above suggested the title for this paper, and it is the author's desire to emphasize the fact that it is necessary for the corporation, like the nation or individual, to be a student.

The secret of the success of a corporation lies in its ability to do better than its present or future competitors. The world does not owe it a living, or if it does, fails to realize the responsibility. So in corporate existence as in any other, it is a matter of the survival of the fittest. This requires, not that it shall do as well as its competitors, but better. The corporation, like the nation, or the individual, should be a student if it is to discover better methods, more efficient apparatus, etc., or, in other words, not only to take advantage of present opportunities, but to discover now ones. The corporation must, of course, work through, and by its individual members and employes, and as a general rule, under present conditions, each is controlled by an established routine which he cannot escape, and usually occupies not only all of the time for which he is paid, but possibly some more for which he is not paid; for this reason, officials have little or no time for concentrated thought or original inquiry, even if so disposed. This condition makes an opportunity for a new and special kind of worker, which the author would designate as a professional student, who, in the service of corporations would devote his efforts to the study in his own field, of existing methods for the purpose of their improvement, and to the discovery of new opportunities. Such man. or men. should not be burdened with any routine duties at all, but be free to carry on the work without interruption or hindrance, and instead of working under the direction of some particular official, it should be rather with the co-operation and assistance of all.

Such man should be one of good judgment and possess or acquire an analytical mental habit. It is not necessary that he have acquired a

large stock of standard statistical information or misinformation, neither that he be able to present a solution of a problem before he understands it, but that he investigate, study and discover the solution of recognized problems, as well as the pure invention of new schemes and methods. It does not follow that he would find literature or precedent for his complete guidance, but would make use of such as far as serviceable; beyond this, he must carry the inquiry by original investigation. The field for such work is unlimited, and its possibilities but little realized, as the author from his experience can testify.

There are difficulties in the way of the realization of this scheme; one is, that it is the general disposition to consider the period of studentship as something to be as quickly outgrown as possible, which leads to the assumption that a sufficient working knowledge has been acquired, with the result that obsolete methods and reasoning largely prevail. This fact must be realized before such work can become possible.

A gentleman said recently to the author, that he was impressed with the frequent assertion "that there were so few opportunities in these days." The opportunities exist, however, and only require means for their discovery.

THE CHAIRMAN: Gentlemen, the paper is open for discussion.

MR. SELEY: This would be a very enticing job if we could induce the railroads, for instance, to employ men on the basis named here; just to study things and not report to anybody until they had the report ready.

So far as the mechanical engineer of a railroad is concerned, I have had the experience to say that he is called on for information on every conceivable subject under the sun. As to the value of his information and reports, it is sometimes doubtful, because he does not always have the opportunity to study the matter as it should properly be studied. A great deal of his work has to go through his hands rapidly, and unless he has a large fund of information of his own, or of other people's available, it is sometimes difficult to see the value of some of his reports. There is no doubt of the necessity for an opportunity to properly investigate; the difficulty is in persuading the corporations, railroads and others, to recognize the fact and to give such officials the opportunities for such study.

MR. W. B. WAGGONER: I was quite impressed with the ideas behind the paper, especially because they back up a little bit some of the ideas that I presented at a previous meeting. In my experience with the Pennsylvania Railroad Lines, I found that they did a great deal of such work as indicated by Mr. Bement. I know of one instance where the terminals were far from being satisfactory, and a special committee was appointed, consisting of the chief train dispatcher or train master, one of the general yardmasters and a maintenance of way engineer. While they were all in active service, they were relieved temporarily from all duties, made a committee to thoroughly investigate the subject of re-arranging terminals, and stayed at the work until they got it done. As an instance of their work, I know at the Columbus, Ohio, yards, where it used to take four hours to get a train through the yards, after the re-arrangement of the yards in accordance with the suggestions of the committee, it took minutes. And the same improvement was seen everywhere. The Chicago yards were also reconstructed in accordance with the suggestions of this same committee. I know that once in our own department two of the fast trains were losing time right along between Pittsburg and Chicago, and the general manager called on the general superintendent for reasons. The reports that came into the motive power office generally were "Engines not steaming." Well, we knew that was not true, because the best power in the line was on those trains. The general superintendent said, however, "It is up to your department to find out where the trouble is." We detailed one of the young men, one of the technical fellows, we call them, to go out and run the matter down, to stay on the job for six months if necessary to find out what the matter was with those trains. His report was very interesting. The result was that there was a general first class shaking up of the crews on those trains. We found that they were often delayed four and five minutes where there should have been no

delay at all. The crews would not work together. I remember one instance where they had a delay of six minutes for loading theatrical baggage because the crew would not assist the baggage master. I only speak of that as the result of a special investigation of those trains that afterwards got in on time.

I think that you will find on the Pennsylvania Lines that they do that special work to a degree that outsiders are not aware of, and that if you could get Pennsylvania railroad men to talk, you would find some very interesting experiences, but as a rule, you hardly ever hear them making any speeches before any clubs, or writing many papers, because it is an unwritten rule with the company to "keep your eyes and ears open and your mouth shut."

I know where a special engineer was engaged in the matter of investigating roundhouses, taking up the question of circular and square roundhouses and arrangement of tracks in the roundhouse, arrangement of machinery and all the details connected with the economical management of roundhouses; an outside man was employed for that special purpose, given all the time that he wanted, paid specially for that investigation. There is no question that any railroad can make an enormous improvement in their operations if special study were given to designs and essential points that operating officers have not time to look after.

MR. BROOKS: For the Pennsylvania railroad I think that this would be all very nice, but the chief difficulty which the rest of us always have is to get any money appropriation through for purposes of investigation. That pretty effectually covers the subject for about every one else outside the Pennsylvania road.

MR. GEORGE WELSBY SCOTT: Mr. Bement's article is a plea for specialism and for research work, and in its final analysis it means doing some things better tomorrow than we have done similar things in the past. It means inquiring into present methods and processes and developing or suggesting improved or more economical ways and means for the future.

Now, there should be no need for a special plea made in this direction, for I venture to say there is not one in this room who, if actively engaged in work, is not continually concerned with questions of improved facilities with respect to his immediate activities. But whether he succeeds in securing or obtaining the desired facilities is another matter. The individual and his thought constitute by no means the entire consideration, much depending upon the conditions around and about him, and very much, indeed, upon those who are above him with respect to position and authority.

True, the particular individual concerned may, or may not, be the most competent one to be intrusted with the work of improvement, even with respect to its general considerations. But let him be ever so competent, or let his thought be the most brilliant possible, yet before he can enter upon action there is this one to give countenance, and that

one to give approval, and, not infrequently, some other one to be encountered whose only notice of the matter may be to disapprove or hold the subject in abeyance.

It requires largeness of capacity, great breadth of view, and a generous character to pass upon many of the suggestions made in the active walks of life, and it by no means follows that because this or that official has been successful in this or that department that he is the best qualified to pass upon matters involving considerations of a practical or technical character with respect to some other department. Many times, too, the mere thought of having to spend money is sufficient to disconcert the one to authorize action, and this result, when so common as to become noticeable, serves to discourage—if not to actually forbid—the suggestion of improvements and betterments.

It would seem that even in this respect large corporations are not altogether dissimilar to the individual or individuals which dominate it; and that where one Carnegie is encountered with his largeness of vision and his ability to adapt means to an end—a money-making end, hence, ability to pay dividends—many others may be noted who pursue a course as if fearful of all kinds of trouble attending the spending of money on one's properties. A reasonably large experience in the improvement of industrial properties, large and small, has long ago demonstrated to me that no legitimate investment can compare with the earning power of money wisely expended in the improvement of properties, whether such properties belong to individuals, co-partnerships or to corporations so extensively concerned as many of the railroads of today.

Mr. Waggoner refers to the work done by and in connection with the Pennsylvania Railroad Company, and well he may, because of the bold, fearless manner in which so many of its gigantic works of improvement are conducted, and I venture to say that those directly concerned could tell us that for every dollar invested in the work of well conceived and well executed improvements, some decided monetary value has been, and is being, realized. The return may be in the form of reduction in operating expenses, or in the ability to operate to a larger extent. But be this as it may, the earning power of the investment is distinctly in evidence.

To sum up, the occasion for improvement in industrial and operative conditions, generally, is unlimited; and there are those whose knowledge, experience and ability renders them fully competent to take up the work of improvement without regard to magnitude. But occasion and ability is not sufficient, for the opportunity must be accorded the competent ones to take action, and such opportunity to take action is clearly within the province of those in authority.

THE CHAIRMAN: One thing that strikes me about this paper is that it is somewhat like a sidetrack with one end to it. You put a man on there, and he has no way to get out at the other end. There is no young man in this country that starts railroading but has an ambition

to get to the top of the ladder, if he can, and where Mr. Waggoner refers to the case where they found the brakeman would not help load baggage, they would not need a man like him. It shows that the operating man ought to have more assistants. He ought to have a first assistant, or a second assistant, and each man should be in line for promotion. In a place like that, if a man is in there he will not stay long unless you add to his salary continually, and as he is learning something every day you cannot keep him there unless he knows that he will be promoted. There ought to be a regular system of promotion, so that the men may have something to look forward to. If a good clerk is put into the office, he will go into some other business unless there is a prospect of a raise in his salary or promotion ahead of him.

MR. WILLARD A. SMITH: I think that the subject under discussion covers to some extent the employment of consulting engineers by railroad systems for special work. While the employment of a special officer or employe of the company to study special subjects undoubtedly would bring very great results, I think that that is rather a more remote thing to look to than the immediate employment of men who are available as consulting engineers.

There are certainly great advantages in bringing a man who is expert and who understands the subject which he has to deal with, from the outside, to examine property, shops and plans. In the first place, if the directory of the road has sufficient confidence in such a man to employ him, they respect his report and are liable to act upon it. The reports of a member of the staff are not always adopted; they are looked upon as a matter of course and are filed away for reference. If a man is specially employed and paid a large fee for the purpose, it is looked upon as waste if the report is not acted upon. Superintendents of Motive Power and other mechanical officials, who have been long connected with the systems on which they are working, have considered them only from the inside. They are not in all cases capable of passing an expert judgment upon what they have and what they are doing, and what would be the best changes to make. A man from the outside who is thoroughly capable and who is familiar with what is being done all over the country in the most advanced practice can frequently make suggestions which are invaluable, and they have the advantage of carrying greater weight, possibly, with the management.

A few years ago there was no one in this country that I know of who was known as a general railway expert. I remember very well making the suggestion some five years ago to a railroad manager who had recently completed the construction of a line on which some remarkable results had been achieved in the handling of large tonnage with powerful locomotives and large capacity cars, that the results which he had achieved there ought to be made more generally available, and that if he would decline to accept any other railway position and hold himself ready for expert work, I believed that he would in a short

time get all he could do. He said, "That is all very well in the abstract, but where is the concrete instance? I do not know of anybody that is looking for an expert of that kind. I should be very glad to enter upon the work if I knew of such a case." I said, "The trouble has been that there has been nobody available. Railroad managements have not known whom to go to—whom they could trust. They have seen the results accomplished on certain roads, but they have not known how it is done, nor how they could get at the same results on their own roads."

The result of that conversation was that I sent to him less than two weeks afterwards a president of a Western railroad who had certain financial matters to carry through and could not command the confidence and influence he desired. I suggested that he ought to have a report of a first class expert on the property. Well, to make a long story short, that expert is today under salary with six railroad companies. He goes over the road four times a year; he holds himself in readiness at any time to examine and report upon any special point. Invariably his reports on a property have proved to be of the greatest value and his suggestions have been generally acted on.

I believe that there is not a railroad company in this country but could, at times, employ the services of a consulting engineer of acknowledged ability to report on special problems with great financial profit; and that the mechanical officers of the roads could well afford to encourage this system, because it will improve their own work in the future and will certainly lead to much greater results than they have found themselves able to accomplish. There are Superintendents of Motive Power and Mechanical Engineers throughout the country who are "eating their hearts out" under conditions where they feel they cannot do justice to themselves nor to the owners of the property; they cannot get consideration for the things that they know ought to be considered, and they do not know how to get at. I think that there is room for independent consulting engineers and railway experts in this country who could be thoroughly relied upon and whose advice would be of great advantage to the railroad companies.

THE CHAIRMAN: Has any other gentleman any remarks to make on this? If not, I will ask Mr. Bement to close his paper.

MR. BEMENT: Mr. Scott's remarks interest me very much. He has supplied one important idea that I hesitated to embody in my paper, which is, if there is any criticism due anybody, it is these Presidents and General Managers, whose sanction must be had, as he very correctly observes. If my brief paper has an idea to advance to anyone it is to such officials. This paper was not written with the idea of presenting an argument favoring the individual; it is a plea for the corporation, and the Pennsylvania Railroad, which has been quoted, is an example which illustrates the matter. I suppose at some time this corporation was less important than some others in the railway business, and there is, of course, a cause for its success.

In reference to the remark of the Chairman, I do not think that a man would feel that he was being sidetracked if properly paid for the work he did.

THE CHAIRMAN: Next we will take up "The Lubrication of Locomotive Valves and Cylinders," by Mr. D. R. MacBain, Master Mechanic, Michigan Central Railroad Company. Mr. MacBain, unfortunately, is not able to be present. I will ask the secretary to read his paper.

THE LUBRICATION OF LOCOMOTIVE VALVES AND CYLINDERS.

By Mr. D. R. MacBain, M. M., Michigan Central R. R. Co.

This I believe to be a subject of more than passing interest to mechanical men and of much interest to the managers of railroads in general.

Fifteen or twenty years ago when the maximum steam pressure was about 140 pounds the question of valve and cylinder lubrication was not so much heard of, the low steam pressure and perhaps a little better class of cast iron used in cylinders and valves, made the matter of proper lubrication a simple one.

It might be said that the reason no particular trouble was had in those days could be credited to the fact that the oil allowance was more liberal, of a better quality, etc., but this from personal experience, I know was not the reason because I was in the business as a locomotive engineer at the time and for several years afterwards and know beyond any doubt that the allowance of oil usually made by mechanical men was sufficient to afford perfect lubrication for valves and cylinders so long as water in boilers was carried at a level that would insure the absence of saturated steam over valve seats and in cylinders.

The writer has watched the raise in steam pressure from 140 pounds to 220 pounds and has noted the gradual increase of the trouble and its attendant results.

The slide valve though balanced to the highest possible per cent that would insure its remaining on the valve seat when working at high speed and short cut off, is, at best, with the present high steam pressure, a difficult problem, when it comes to the matter of lubrication.

This is particularly true on runs where the throttle is not closed for a distance of 25 miles and upwards, and where for reasons of fuel economy and in the attempt to get the best out of the engine, the engineer uses a wide throttle, notwithstanding the contentions of the lubricator men to the contrary, when they promise to deliver the oil at the steam chest under "any and all conditions."

A long experience as a road foreman of engines and a most careful effort on the part of the writer to bring about the promised results has failed to convince him that the oil can be delivered to the steam chest under "any and all conditions. On the contrary, I am perfectly satisfied that on long runs such as are described above in this paper, either one or the other of two things must be done, ease the throttle off frequently so that steam chest pressure will fall much below that of the boiler or run with a longer cut off and a throttle opening that will keep steam chest pressure down enough below the lubricator through the oil pipe to the steam chest all the time when th engine is working.

The long cut off and short throttle has become the most acceptable method among enginemen and it is safe to say that this fact is responsible in a large degree for the increase in fuel consumption that has been pretty much universal.

If enginemen would persevere in this matter of seeing that the valves and cylinders of the locomotives they are running are properly oiled before starting out and that no water more than is absolutely unavoidable is worked over valve seats and cylinders, no difficulty would be experienced in keeping the rubbing surfaces fairly well lubricated even with a wide open throttle, if same is eased off (for a moment) very fine, say every five to eight miles.

On freight trains the cut off is seldom so short that the pulsations or variations of pressure in steam chest will not permit of the oil passing freely from the lubricator forward and what we recommend in this case is absence of saturated steam and enough oil.

The piston valve has taken away from the enginemen much of the annoyance experienced with the slide valve, the two particular items of annoyance being the noise caused by the reverse lever trying to tear away from its notch in the quadrant and the jerking, incidental to slide valve, when it was desired to change the cut off.

The piston, valve, however, does get dry and very dry, but it will not rattle, nor jerk the arms out of the engineer when cut off is being changed.

The fact that the engineer is secure from annoyance and physical effort is something which, it is safe I believe, to say, is costing railroad companies a lot of money, not alone in the matter of unnecessary wear and tear but also in unnecessary fuel consumption.

Feeling as we do that the piston valve has simply transferred the worry about lubrication from the engineer to the stock holder, it would seem that in order that the latter may have justice, some rule should be laid down to govern the matter of quantity of oil to be used and enginemen educated to understand and respect same.

Drops per minute mean nothing, unless work performed per minute is taken into account.

Water glasses on locomotives should not be more than three gauges long.

Proper facilities should be provided for getting rid of condensation easily and quickly when starting up, and rod packing should be kept in good condition in order that the oil may not be wasted.

THE CHAIRMAN: Here is a chance for the lubricator man to get in his work, if we can hear from him on the delivery of oil.

MR. BEMENT: It will not do any good to deliver the oil to the valve if the water will wash it away, and I believe there is a great deal more trouble in lubrication caused by wet steam than is realized.

THE CHAIRMAN: Mr. Wickhorst, in your tests on the C., B. & Q., have you tested any lubricators under high pressure to see how they operate?

MR. W. H. WICKHORST (C., B. & Q.): No, Mr. Chairman, we have not.

A. N. WILLSIE (C., B. & Q. Ry.): I came here in the hopes of learning something about lubricating valves and cylinders, and am very sorry Mr. MacBain is not here to take charge of this subject, as it is one which should attract more than ordinary interest, not merely on account of the cost of oil, but the much more important fact of fuel economy, which depends greatly on the manner in which valves and cylinders are lubricated. The majority of lubricator men lay stress on the fact that they will put the oil down in the steam chests of large freight engines when working at their full capacity, but it has been my experience that it is much more difficult to satisfactorily lubricate our fast passenger engines when running at high speed and with a short cut off. I believe the late improved lubricators are good lubricators and put the oil to the valves quite satisfactorily, but the fact must not be lost sight of that regardless of the amount of oil put in the steam chest there is always a certain amount of surface of the valve seat and the valve face that is poorly lubricated on account of these parts not being exposed to the oil. This is more especially so with slide valve engines. On runs such as fast mail trains where the tonnage is light, speed fast, cut off short, and throttle is not closed for a distance of 80 miles or so, it can very readily be seen such engines will be difficult to lubricate properly and it will probably be necessary to ease off on the throttle or close same entirely, but I am of the opinion that this alone will not give the desired result. I think the links should be dropped allowing valves to travel farther and throttle should be opened carefully before links are hooked up again so as to distribute oil thoroughly over the wearing surface. Regarding piston valve engines, I believe Mr. MacBain is correct in saying that they require fully as much oil as engines with slide valves. As long as the valves are apparently working smoothly and the lever does not drive the engineer out of the cab, he is liable to become negligent as to the working of the lubricator and the carrying of the water and allowing saturated steam to work through the valves and cylinders, resulting in a very extravagant performance of a locomotive both as to wear and tear and fuel consumed. I do not think there is any doubt but that piston valve engines are often run with valves and cylinders insufficiently lubricated and at the same time the engineer feels that everything is working satisfactorily because the reverse lever is quiet and handles easily.

THE CHAIRMAN: There is one point that occurs to me in regard to economy in oil. Every engineer for years past has been allowed so little oil, a half pint or a pint of oil to so many miles. I think that is wrong. There is nothing said if he burns up a ton of coal more than necessary, yet that coal costs more money than the oil he uses. I think it would be more economy to hold them up on the use of coal than on the use of oil. Mr. MacBain will be given an opportunity to reply to Mr. Willsie.

MR. MACBAIN: (Communicated) The points I wished to make if I had been able to attend the meeting were that the short water glass that would not show more than three gauges of water is necessary, otherwise engineers would carry water too high. Standard water glasses on the Michigan Central Railroad are but long enough to show three gauges. This was the best move we ever made toward cutting out trouble in lubricating valves.

The matter of lubricating piston valves needs more attention on the part of men in charge of the mechanical end of the work than does slide valves because the piston valve will get very dry and the cylinders as well before the engineers will notice anything wrong. This on account of the absence of jerking in the reverse lever.

A notable incident of this was recently developed on a test made by the Mechanical Engineer with an "Atlantic" type of engine. Leaving the terminal the right valve feed of the lubricator was set to feed four drops per minute and the left one set to feed nine drops per minute. After running about forty miles, during which run no water was allowed to pass over the valve seats, in starting from a station, the Assistant Mechanical Engineer, who was on the front taking cards, drew attention to the right valve stem which was apparently standing still at the end of each stroke until the engine made what appeared to be about one-eighth of a turn, when it would let go with a jerk. In striking contrast to this, the left valve, which had been given nine drops per minute, worked perfectly smooth. This engine was equipped with piston valves of internal admission type and at no time on the trip was there any suggestion of a jerk on the reverse lever. The fact that the right cylinder was dry was much in evidence by the riding of the engine.

With reference to the matter of oil delivery at the steam chest, I am satisfied that no lubricator in the market at the present time will deliver the oil except when steam chest pressure is lower than that of boiler, and further that the choke plug at the lubricator is preferable to that on the steam chest, as any stoppage of same is more readily detected. This can be proven by tapping the oil pipe near the steam chest and putting in a small cock which can be opened at will when the engine is working at high speed and with short cut off. After a thirty-minute run under above conditions water only can be found in the oil pipe at the point mentioned.

I believe that in most cases the allowance of oil made to engineers is ample if properly used, but the tendency to use the valve oil for other purposes than that of oiling valves, on the part of enginemen, is something that is causing much waste of coal and loss of capacity.

THE CHAIRMAN: If no one has anything further to say, a motion to adjourn is in order.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

Organized April, 1884 Incorporated March, 1897

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday, March 15th, 1904; Mr. LeGrand Parish, vice-president, in the chair. The meeting was called to order at 2:30 p. m.

Among those present, the following registered:

Ault, C. B.
Averill, E. A.
Ball, W. J.
Bischoff, G. A.
Bower, J. G.
Brandt, F. W.
Brenneman, H. N.
Brooks, P. R.
Brown, R. L.
Bryant, W. E.
Cooke, W. J.
Crosman, W. D.
Cushing, G. W.
Dunham, W. E.
Fenn, F. D.
Gilbert, E. A.
Gilman, C. R.
Goss, W. F. M.
Guilford, A. L.
Harris, E. K.
Haig, M. H.
Heath, John
Hennessey, J. J.
Hickok, C. N.
Hill, J. W.
Hinson, J. A.
Jackson, Thos.
Jefferson, E. Z.
Johnson, W. T.
Johnstone, H. C.
Keeler, Sanford
Ketchum, I. J.
Long, J. H.
Maus, N.
McAlpine, A. R.
McCarthy, J. J.
McLeish, W. J.
Meissner, O. W.
Midgley, A. W.
Mills, G. F.
Morrison, G. D.
Owen, Elmo
Patterson, J. B.
Peck, P. H.
Phillips, L. R.
Replogle, J. L.
Rennolds, W. C.
Robinson, Jay G.
Rowley, S. T.
Sanborn, J. G.
Schroyer, C. A.
Setchel, J. H.
Sharp, W. E.
Sherman, L. B.
Shields, H. S.
Shults, F. K.
Slater, Frank
Stimson, O. M.
Sullivan, S. F.
Symington, E. H.
Taylor, J. W.
Toothe, E. S.
Thurnauer, Gustav
Traver, W. H.
Wells, L. R.
Wickersham, R. S.
Wilson, G. L.
Woods, E. L.
Woods, J. L.

THE CHAIRMAN: The first order of business will be the approval of the minutes as printed. If there are no objections, they will stand approved.

The Secretary then read the following report:

Membership, February		1078
Dropped, mail returned (C. R. Holstrom, R. H. Montgomery, F. J. Bird, W. S. Worman, H. B. Gregg)	5	
Resigned (J. C. Stuart, M. Ryan, F. J. Hogan, H. E. Williamson, H. Schlacks, R. W. Bushnell, F. A. Haughton)	7	
Died (J. G. Riley)	1	13
		1065
New members	11	
Reinstated	2	13
Total		1078

New members:

NAME.	OCCUPATION AND ADDRESS.	PROPOSED BY.
F. Von Schlegell,	American Loco. Equipment Co., Chicago	J. W. Taylor.
Jno. Conrath,	National Car Lines Co., Chicago	D. F. Jennings.
T. E. Slade,	Asst. Engr., C. & N. W. Ry., Cedar Rapids, Ia.	R. C. Smith.
A. E. Stephens,	Latrobe Steel & Coupler Co., Chicago	H. R. Curtis.
W. D. Epler,	Piece Work Inspector, C., B. & Q. R. R., Beardstown, Ill.	T. L. Smith.
Chas. E. Wilson,	International Steam Pump Co., Chicago	Wm. Hudson.
B. J. Sweatt,	Div. Engr., C. & N. Q. Ry., Boone, Ia.	R. C. Smith.
A. T. Hardin,	Engr. M. of W., N. Y. C. & H. R. R., New York City	J. W. Taylor.
L. K. Gillson,	Patent Attorney, Chicago	G. W. Scott.
W. N. McMunn,	Latrobe Steel & Coupler Co., Chicago	H. R. Curtis.
L. R. Phillips,	National Tube Co., Chicago	F. K. Shultz.

REINSTATED:

C. H. Osborne,	Foreman, C. & N. W. Ry., Chicago	W. E. Dunham.
C. B. Holdrege,	309 Western Union Bldg., Chicago	J. W. Taylor.

THE SECRETARY: Mr. Chairman, before we begin the regular order to-day, I would like to give notice of the meeting next month. At our April meetiing the following subjects will be presented: 1. "The Steam Turbine," by Mr. C. G. Y. King of the General Electric Co. This lecture or paper will be illustrated by stereopticon views and will be highly interesting. 2. "The Value of Heating Surface," by Mr. H. H. Vaughan, S. M. P. Can. Pac. Ry. I will endeavor to get advance copies of Mr. Vaughan's paper to the members earlier in the month than for this meeting, so you will have a chance to read and study it. 3. The report of the Committee on Revision of the Rules of Interchange will be considered and the recommendations of the Club made up for the Arbitration Committee. The Club Committee has sent out circulars asking for the suggestions of members and I would ask that you send in your replies to Mr. Schroyer, the chairman, not later than April 1st, so that the committee can have time to prepare its report for the April meeting.

THE CHAIRMAN: The first paper this afternoon will be on "Steel in Car Construction," by Mr. C. A. Seley.

Mr. Seley then read the following paper:

STEEL IN CAR CONSTRUCTION.

By C. A. Seley, M. E., C. R. I. & P. Ry.

This is a subject which is being considered more or less by the managements of railroads generally. The eastern roads, and particularly the coal and ore carriers, have purchased large numbers of steel hoppers and gondolas. The development of most of these was a direct change of material from wood to steel instead of the general introduction of steel parts.

This was brought about largely by commercial enterprise and not a gradual evolution as has generally been the case with other railway equipment. One important coal carrying road has adapted the composite construction, employing steel for the frame members which carry the load and wood for the body which merely retains or holds the lading. So far as trucks are concerned very little if any wood is now found in any late designs, particularly of the larger capacities.

On western roads the steel cars are not so numerous. A few roads have something, coal cars mainly, although quite a number of steel underframe box cars have been put into service. The writer recently examined a wreck in which 16 box cars were derailed, a number of which had steel underframes. The ease of handling and the greater salvage of these cars was very noticeable as compared with the wooden cars. Steel has been used, although not altogether successfully, in combination with wood in underframing.

Steel center sills in an otherwise wooden frame are liable to an excessive load as it is impossible to make the wooden sills work within the range of deflection allowable in the steel sills.

A great improvement is noticeable in the bolsters of wooden cars in which metal either in the solid or a built up construction is now used to the total exclusion of wood.

There is still a very weak spot, or, rather, two of them in our box car designs, and those are the ends. Heavy switching shocks and the heavier trains and engines in road service have brought about a considrable increase of mortality in that respect in both old and new cars and no wood construction is adequate to prevent this trouble.

If ever there was a place for steel it is the framing of box car ends. One prominent eastern road is using structurel steel in the sides of box cars, not as members of the framing, but to prevent bulging of the wooden side framing. The time is rapidly approaching, if it is not here already, when we should consider steel for the entire framing of box cars.

Long, heavy timber for sills is getting expensive and oak for framing has well nigh disappeared. There is a real need for stronger cars to withstand the strenuous movement of modern transportation. The box car, being the principal type of car used in our middle western traffic, is the one to which attention should be paid and so designed that steel shall take its place for all of the carrying members.

The ideal box car will have a complete steel frame up to and including the side and end plates and probably the carlines. Such a car need be no heavier than present weight for same capacity, strong ends can be provided; that part of the load coming to the sides can be carried by the upper framing, bulging need not be taken care of by special provisions, and the general cost of maintenance of such a car will be a fraction of that required for the keeping up of old style cars.

The writer had the opportunity of making a design somewhat on these lines a few years ago from which 100 cars were built. The side framing was light and the only uncertainty was the possibility of bulging under a flowing load, as of grain.

About 18 months after the cars were put into service an inquiry was made regarding the condition of the cars and in particular as to any signs of bulging. The reply was very satisfactory and a portion is here quoted.

"Replying to your letter of the 9th about steel frame box cars. You will recall that we have 100 of these cars in service, and to their credit. They visit the repair tracks so little that we have had practically no opportunity of keeping close watch on their performance.

"We have one at the shops today, No. 60,407, which was among the first turned out. It was shopped for some air brake repairs, a broken pipe, or something of the kind. The car frame is in perfect condition. From the debris of the car floor I note it has recently been loaded with oats, at another time with shelled corn, and from marks on the siding and lining, it has been at one time loaded with something nearly to the roof. I cannot determine exactly what this lading was, but it was something that blackened more or less the sides of the car. There are no signs of lateral bulging and all of the different steel parts appear to be perfectly straight and in as good condition as when new. The lining in the car is not broken, as sometimes occurs in rough handling of heavy package freight; but, as this car has been in service 18 months, it has probably met with the various kinds of treatment accorded rolling stock in this neighborhood.

"I made inquiry among our foreman and inspectors with reference to this group of cars, and they all report the frames in perfect order on the cars examined by them, except in the case of one which was side wiped. We managed to straighten this one up cold and did not have to cut it apart; the light sections readily lend themselves to this treatment. As we make all repairs to steel frame cars of the various kinds, it is fair to assume nothing serious has happened to this group of box cars."

It has been laid down as a principle, and perhaps properly, that the carrying strength should be provided in the underframing of wooden box and other cars having a superstructure.

The upper framing therefore is light and contributes little in carrying the load. Shrinkage and the working of the body loosens the structure generally and tightening of rods and renailing of siding are considerable items in the expense of maintenance.

It has been conclusively proved that by the use of steel in about 5500 cars, embracing hoppers, gondolas and box cars on the N. & W. Ry. that the side framing will successfully carry that portion of the load coming to the sides. In a wooden framed car the braces are compression members and if properly applied give the cars its initial camber without the assistance of the truss rods. The posts are not the tension members, as they are not attached to sills or plates. The side framing rods are the tension members, but are generally inadequate both in size and bearing to take their lading if required to carry much of a load.

In a steel frame for a box car both posts and braces are riveted to sills and plates and while the braces do not contribute lateral strength, the posts do, both by their inherent strength due to their section and also by the bowstring action, if it may be so termed. As their load is increased this action comes more and more into play, stiffening the posts and preventing bulging. In the 100 box cars previously referred to the posts were 3-inch light channels, and you have heard the testimony in regard to their action.

It might be better to use the Z-bar section, and this has been done in later designs.

The end framing when of steel can be thoroughly tied, using angles for corners and I-beams for end intermediate posts, and the possibilities in strengthening these notoriously weak parts of the framing are immense.

With the side framing members securely riveted, it will be seen that there can be no fore and aft working of the body to loosen the nailing of the sheathing and an important gain in maintenance results.

With the shallow side sills used in such construction, inspection is greatly facilitated.

Some years ago a lot of hopper cars were built with 15-inch channel side sills. Later another lot of a different design with 8-inch sills were built to the strongly marked approval of the car inspectors. Easy inspection means better inspection and when made difficult by covering the parts which should be easily accessible, defects will be missed. The steel underframe, while it has very good points, has this unfavorable feature. A difficult point in the design of steel frame box cars is to provide stable nailing foundation for the sheathing and lining without contributing materially to the weight and cost in building. This is not an insuperable difficulty, however, as has been demonstrated.

There is a medium ground where weight, strength and low cost of maintenance will meet. While excessive light weight of car means a high percentage of possible revenue load it also means high cost of maintenance, as no structure subject to shock can be whittled down without increasing the liability to earlier failure and an increased repair account. It is possible to design a steel frame box car of lighter weight than a well designed wooden car of like capacity. It should cost little if any more and the difference between the two in the longer life and decreased cost of maintenance, if capitalized, will warrant the increased cost and help pay a dividend besides.

There has been some discussion of late regarding the use of steel in passenger equipment. One Chicago road has done some interesting pioneering in this line, but it is probable that progress will be slow in the development of this use of steel. It will come, however, just as surely as steel has taken the place of wood in bridges, tender frames and freight car framing.

We are using steel extensively for platforms now and for plating sills and its further introduction into the framing may be slow, but it will be sure. The very long timber required for passenger car sills is expensive and steel sills can be obtained full length if desired, although this is not necessary owing to the readiness of splicing. It may take some experimenting to make a steel frame that will be satisfactory in regard to necessary stiffness, yet not be so rigid as to unpleasantly affect the riding qualities.

Baggage, postal and combination cars having unsymmetrical, broken side framing would require steel underframing, under trussed, and four sills are sufficient with riveted-in cross ties or beams to support intermediate nailing strips. Other cars having an unbroken side framing might have a steel truss in the sides well bracketed to the center sills and with heavy body bolsters such a construction could be made as to avoid under trussing.

Designing the steel frame will not be as difficult as arranging for the attachment of the wood construction necessary in the structure. The corner and door posts and end framing can be sufficiently of steel to minimize danger of telescoping if not prevent it entirely.

The foregoing suggestions are offered based on an experience in freight work only so that they are open to objection and criticism.

I trust you will pardon the reiteration in this paper of considerable that has appeared before in contributions to Railway Clubs and the Railway press. It is only by continual discussion that this subject can be worked out to practical conclusions and steel be given its proper place in car construction.

THE CHAIRMAN: The paper is before you for discussion, gentlemen. Mr. Schroyer, will you open the discussion?

MR. C. A. SCHROYER (C. & N. W. R. R.): I would prefer to hear from those who have steel cars. But as you have called on me, I might say something as regards why we are not using steel cars. I have read Mr. Seley's paper with a great deal of interest, and if I were selling steel cars, what he has said in his paper woud be just about what I would put to the other fellow whom I was trying to induce to buy. Sometimes the other fellow has some other stories, and sometimes these steel car fellows that come up to see me can tell a longer story.

One of the drawbacks is that every fellow that gets up a steel car and puts on an angle iron, or a brace of steel, or clips off the corner of an angle iron, or who will bend it at an acute angle, or something of that sort, will go and get a patent and another fellow will put in a brace of some sort and will get a patent on that, so I venture the assertion that

there are more patents on steel cars to-day than any other thing you can mention in connection with the car department of the railroad. That is a great drawback, and I think it is a mistake, going into anything that is covered by so many patents, as most of these cars are.

My idea of a steel car is that it should be one that can be built clear through by anybody in any shop that it can be handled in. To the man that comes to me and talks to me about steel cars, I sometimes say, "What is that car going to cost?" "Well, that car will cost anywhere from $900 to $1,300." If we were going to buy a thousand steel cars, they would cost us $1,300,000 for these cars. If we buy one thousand wooden cars at the prevailing prices of to-day (and wood, as yet, is sufficiently plentiful to justify us in the use of wooden cars awhile longer), we can get those wooden cars for about $600,000 to $700,000. Now, the difference is just about double—we pay twice as much for a thousand steel cars as we pay for the same number of wooden cars. Now, suppose we take that extra $700,000 and buy another thousand wooden cars, what can we do? With that thousand cars on the road we can have enough to maintain all the balance of the 54,000 cars that we have in service to-day. That means wheels, axles, oil, waste, brasses and every single item of expenditure that there may be on those cars, so that if, instead of buying a thousand steel cars, we will buy two thousand wooden cars, we will be a great deal better off than we would be if we bought the high priced cars. We do not think any railroad is justified in buying steel cars unless its capacity is 80,000 or 100,000 pounds. It costs more money to pull a 60,000 pound load in a 100,000 pound car than it would in a 60,000 pound car. That is due to the diameter of the journals and size of the wheels. And the average load that we get for our 60,000 pound cars, you all know, if you know anything about this, falls so far below the capacity of the car that it would as yet, with us, be a loss of revenue to buy the heavy carrying capacity car when we cannot get half the average load for a lighter car. We would be justified in buying a steel car if we can get a maximum load. "Well," they say, "you can get a maximum load of coal and you can get a maximum load of ore, or a maximum load of grain." Yes, we can, but the reason we do not buy the ore car is because if we buy a 100,000-pound ore car, we have to haul it on a wheel base of 18 to 20 feet, 24 feet being the total length over the drawbars of the car. The result is that we have such an extremely heavy load on so short a wheel base that we are not justified in hauling a load as heavy as that over bridges, and the center of gravity on a car so short as that is raised so high that it makes it very objectionable and hard on the roadbed.

We have the 80,000-pound wooden car, and we can buy very nearly two of them for one of the others, and the condition under which those cars are operated is such that two wooden cars will earn us a great deal more money than a steel car possibly could do.

In the matter of coal cars, where we can get a maximum load at all times, one of the greatest drawbacks is the fact that you have to load your car and take it out to a country side track and hold your car until

the dealer has disposed of the coal to his customers. In the case of a flat car and box car, we do not think that we have as yet arrived at the time when we would be justified in buying steel cars at an increase of cost.

MR. J. J. HENNESSY: (C., M. & S. P. Ry.): Mr. President, I feel a great deal as Mr. Schroyer does, that I would like to hear from some of the members who are more familiar with the steel car than I am, although I have given the steel cars very close inspection since they have come into general service.

I think the success of the steel car depends a great deal on the class of freight that you want to haul in it. For illustration, I believe that if our people were going to build a 100,000-pound capacity, self-cleaning, hopper coal car I would recommend a metal car, but our people are not prepared to handle that class of cars at the present time. I do not know of any other class of car that I could conscientiously recommend that would be a paying investment on the increased first cost to the railroad companies.

In looking over the paper to-day, which I read with a great deal of interest, I am inclined to believe that possibly the first step that should be taken is to strengthen the draft gear and draft sills of our wooden cars. If we will maintain the center sills in a wooden car, I think the life of the car will be greatly prolonged. The life of eighteen months of any well constructed car practically gives us no knowledge; a wooden car that was constructed eighteen months ago I certainly would not expect to see on the repair track, barring accidents. I believe the first thing we should do in leaving the wooden car—I am speaking now more particularly of common box cars—is to build wooden cars with the metal center sills. My experience has not been the same as Mr. Seley's. In May, 1901, we built fifty wooden cars with metal center sills. The following year, in the early part of 1902 we built five hundred more. Up to the present time we have never replaced one of these center sills, notwithstanding the fact that the gear is riveted directly to same. Our folks have been so well pleased with the result, that we have just completed building five hundred 50 tons capacity coal cars with the same construction.

In discussing the question of metal framed box cars, there are many things to be taken into consideration. The design shown in the paper is somewhat different from the majority of box cars that are now in service, although I had the pleasure of inspecting half a dozen stock cars very recently that were built about as this paper describes, metal underframing, metal posts and metal plates, braces riveted to the side sills and to the plates. The inspection developed this, that although the cars were not three months old, one of them under load showed the metal underframing to be bent down about one inch in center; another was out of line about one inch sideways, and bent down about three-quarters of an inch; two more were in reasonably good condition and in one the top showed signs of working. But as that style of car is very

little in service, let us discuss more the cars that are actually in service with the metal underframing.

As I said before, I believe the metal car is here to stay, but I question very much whether the time has arrived that it is a good financial investment for the Western roads. The average metal car has a wooden side sill, 5x6 inches, or I will call it a wooden rest for posts and braces, bolted onto the side of the frame. The posts and braces which are of wood, rest on this wooden structure; the plate and carlines are of wood.

Now let us see what the deterioration of a box car really is. The deterioration that counts very rapidly on wooden cars and cars with metal underframe alike is the roof, floor, siding, doors, etc. The side sills on any wooden car will last from fifteen to twenty years, meaning a wooden box car, barring accidents. The deterioration on the brakes of a metal car and a wooden car is the same; it will be the same on the draft gear, it makes no difference what gear you put in, if anything, it will be a little less on the wooden car because it cushions better.

Really the only thing that you would have to compare to get a comparative statement of the cost of maintenance is the difference between the side sills and the intermediate sills. I do not think that any of the metal box cars are old enough to make any comparative statement of what the maintenance of these are going to be in comparison with the wooden cars.

There is another thing that I have noticed, and I have watched it carefully, I am not prejudiced at all, because I believe that we all should keep up with the times; if the metal car or the metal underframing is the correct thing, I believe that railroad men cannot know it too soon. There is no man, in my opinion, as great a fool as the man that tries to fool himself. If you will go through the yards and inspect one hundred or two hundred cars, wooden cars properly constructed, two or three years ago, with the same number of metal underframe cars constructed at the same time, I think you will become convinced that the metal underframe car is much harder on the wooden upper structure.

MR. SCHROYER: Mr. Hennessey was looking at me when he was talking, and I am not sure whether I said anything to make him mad or not; if so, I want to apologize. I thought he was getting madder all the time he was talking.

MR. HENNESSEY: I have been doing business with Mr. Schroyer for seven or eight years, and he has hardly ever talked that he did not make me mad. (Laughter.)

MR. JOSEPH BUKER (Illinois Central R. R.): We have no steel cars, nor steel underframed cars. I am not in position to say anything very much for or against the steel cars. I would like to hear from somebody that has steel cars.

THE CHAIRMAN: Have you any passenger cars with steel under framing?

MR. BUKER: We have six passenger cars, all steel, but they have not been in service long enough to give any idea as to what results we

will obtain from their use. They are suburban cars, and, in fact, they have been in service only about six weeks or two months.

MR. J. E. KEEGAN (G. R. & I. R. R.): The line with which I am connected has a considerable number of steel cars as well as cars with steel underframing. We also handle a large number of steel and steel underframe cars belonging to Pennsylvania Lines. The only objection to their use on our Northern Division is that mentioned by Mr. Schroyer—inability to load with forest products to their capacity and keep inside of load limits and clearances. We find, however, that the cost of maintenance of freight cars is lessened by the presence of a comparatively large number of steel or steel underframe cars in the equipment through the lessened number of cars requiring repairs.

These cars have not been in use sufficiently long, however, to enable us to furnish figures showing comparative cost of maintenance.

MR. SCHROYER: I would like to say a word more in regard to the economy in the use of steel cars on our Western roads. I do not know whether you are aware of the fact that the interest on the investment in the higher priced steel car above the interest on the investment of the wooden car as built to-day, represents enough money to maintain all the wooden cars that are in service to-day and to rebuild such wooden cars as may be destroyed as result of wrecks, natural wear and decay.

In the matter of wheels and axles, brasses, drawbars, air brakes, roofing, siding, doors and a large number of other items, they are subject to the same wear and tear in the steel car that they are in the wooden car so that any difference in favor of the high priced steel car must be affected by its decreased cost of maintaining the iron frame of the bottom of the car and its carrying capacity. Where the business of a road is such as to enable it to get maximum loads, to load and unload quickly, the steel car may be economical, but, where the conditions existing are such that this cannot be done, the two wooden cars of the lighter carrying capacity, I consider more profitable than a single car of high carrying capacity.

I believe that the time is coming, when, as a result of the scarcity of timber, we will be compelled to build the high priced steel cars, but when we are forced to do so, I think they should be built of mechant bar sections that can be handled in the shops by the same force that is now handling the wooden cars.

THE CHAIRMAN: Mr. Peck, have you anything to say on the subject?

MR. P. H. PECK (C. & W. I. R. R.): My experience has been that heavy steel cars with steel underframing, when they are heavily loaded, the frame will sag under the heavy load and when the slack comes, it will come up in the center. We have steel cars about nine years old, coal cars that are made of "I" beams. The sills were first removed this year and I am going to make them of wood, as they are so rusted out that we cannot do anything with them. The sills were rather light and rather narrow, but they are entirely rusted out.

I have also found that repairs on steel cars are very expensive, and that a different class of men is required to do the work, and more expensive tools have to be used.

We had some work to do on a steel car some time ago that on a wooden car would have cost $1.25 to repair it, but it cost me $40 to get it repaired because I had to ship it to Joliet to get the work done. But if everybody had steel cars and had the tools which are required for work on them, possibly the cost of repairs would be reduced.

THE CHAIRMAN: If there are any representatives of steel car companies in the room, we shall be pleased to hear from them.

MR. PECK: If there are any steel car men around, I think they are afraid to show themselves. We would like to hear from them. We have told them what the bad points are, and if there are some good points, we want to find that out.

MR. SCHROYER: I know there is one here but I will not tell on him.

THE CHAIRMAN: I was afraid we were taking advantage of their absence but if there is one present we would like to hear from him.

MR. BALL (Bettendorf Axle Co.): I represent a steel car company, but the work so far has been mainly on tank cars, and those are not under discussion. As far as the construction of box and coal cars is concerned, I cannot say very much.

MR. SCHROYER: I think the membership will be glad to hear from Mr. Parish on the subject.

THE CHAIRMAN: I have had very little to do with steel cars from the fact that nearly all of them are handled on the east end of our road, and therefore, I do not feel qualified to discuss the merits of steel cars from actual observation. I hope we can hear from some more of our friends in the steel car business, because now is the time for them to present their case.

MR. SCHROYER: There is one phase of the question that I would like to have Mr. Seley say something on that he has not mentioned in the paper, and that I think he must know something about, and that is, what economy there would be to any road in this Western country in building a steel car to-day for such a general service as they have on the Rock Island road to-day. He is running west now and he knows the conditions that exist in these Western roads, and I would like to hear from his as to whether he thinks the steel car would be economical, both from the standpoint as a money earner and as to maintenance.

MI SELEY: I will take up that matter in closing.

THE CHAIRMAN: Mr. Stimson, are you using steel construction in refrigerator car work at all?

MR. O. M. STIMSON (M. C. B.-S. R. L. C.): Some two years ago we went carefully into the matter of steel construction for refrigerator cars, and we found, as Mr. Schroyer has stated, viz.: that the first cost of a refrigerator car, in which steel was incorporated for underframing, posts, braces, plates, carlines, etc., was nearly double of that of our present construction.

We concluded, I believe, that it would have been possible to properly insulate a car having steel construction, but when the first cost, the interest on the investment the depreciation, and the cost of maintenance were considered, in comparison with the wooden cars, together with the

fact that our cars are scarcely ever loaded with more than 30,000 or 40,000 pounds, it was apparent that the wooden car was much the better investment.

Our company has, therefore, not even made experiments along the line of steel construction for refrigerator cars.

MR. WILLIAM FORSYTH (Railway Age): I thought that when Mr. Seley's paper would be discussed to-day, that we would start right in and discuss the paper in regard to the general subject of steel cars, and the development of them, different matters of construction, and so on. I did not expect that the question of comparative merits of steel cars and wooden cars would come up so prominently as it has, and in this discussion I am still surprised to find that the Western men are so much opposed to the steel cars.

I do not see why the conditions in the West are so far different from those in the East as to decidedly affect the steel car question. We have here in the West grain which can be loaded in capacity, certainly, in large quantities; we have coal, which can be loaded to capacity, we have lumber, we have lots of heavy merchandise, and I say, I do not see why the conditions here are so far different from those in the East, and the Eastern roads have certainly gone into the steel car in a wholesale way, and if they have made a mistake it is a pretty big mistake.

As far as economy is concerned as related to capacity, I think they have demonstrated pretty carefully that they were all right, that even if they did not get full capacity, that the steel car would still be economical for the reason that the lading was so much larger, even if not always fully loaded. That question of maximum capacity related to the economy of cars has been threshed over so often that I think traffic men understand it pretty well, and if I am not mistaken, they have come to the conclusion that the high capacity car is the economical car, and that therefore the steel car, which is a high capacity car, would be the most economical, and I believe that the experience with it on the larger roads in the east has proved it to be so.

Mr. Schroyer gives some surprising figures in regard to the repairs of steel cars, which I think must be based on pretty limited experience, because they are quite different from those of many other roads. He mentioned, I remember, the fact that the cost of repairs to draft gear even on steel cars is about equal to that on the wooden car. On the contrary we all know that the cost of repairs to the draft rigging on steel cars is very small.

The other argument against steel cars has been their high cost and the interest charge on that high cost. That may have been true in the past, but a large number of steel cars were built at times when the railroads had to have cars and when they paid any price that was asked for them in order to get them, and the car shops were crowded. That condition does not exist to-day. The steel car companies would be glad to build cars at a great deal less price than they charged in 1902, and I imagine that the steel car which Mr. Schroyer talked about as costing $1,200, could be bought to-day at a much lower price, so that those

figures in regard to original costs and interest will have to be largely revised in order to make a fair comparison at the present day.

Coming now to Mr. Seley's paper. He first mentions the body bolster, or the improvement of bolsters in wooden cars. While the metal bolster for such cars has been approved in a measure, it has been a difficult thing to apply the two-bar bolsters to wooden cars on account of the interference with the wooden sills, and the bolster which is now generally used is the most uneconomical structure, probably, that there is about the car. It weighs more in proportion to its strength and stiffness than any other metal part of the wooden cars.

The box car with the upper frame of steel which he refers to, I am sorry that he did not illustrate in this paper. I do not know whether it has ever been illustrated, but I hope to see the plan; the record of it is certainly quite favorable.

Then the real interesting part of this paper, I think, is that which relates to steel in the passenger car construction, and I am glad to see that Mr. Seley not only has faith in steel coal cars, but he even believes that in the future passenger cars are to be built of steel, and I agree with him, for I think the time has come now when we shall begin to think seriously of making a stronger car out of steel, instead of such heavy cars as we have in our passenger equipment to-day.

The matter of arranging for the attachment of the wood to the steel in passenger car construction it seems is a difficult thing, and in view of attempts that have been made in this country so far, they have found it is rather an awkward thing. That is something in which we have had little experience, but I remember when I was in France fifteen years ago, I saw steel passenger cars 50 feet long, and now in England they are building large cars 65 feet long with six-wheel trucks and steel underframes; in fact, the passenger equipment of the best part of Europe is all of steel underframe, and some have metal bodies. They have learned to finish up the inside of these cars making them comfortable and attractive, and I think there is where we can learn something when we come to the time when we must go into steel construction for passenger cars.

MR. SCHROYER: I would like to say that the price of cars as quoted by me was given to me by a steel car man less than a week ago. He quoted to me the price of a box car at $1,300. I made comparison between that car and the car that we are using.

I hardly think it is fair for a man to get up in these meetings and to have put on the records of this club that the wooden car that we are building to-day is weak and poor, especially referring to a passenger car. Now, there is not a man that knows anything about a passenger car but knows that the wood cannot be put together better than it is being done to-day by the car builders of this country, that a stiffer, better car throughout cannot be built, and you must all acknowledge that wood has an element to cushion the blows that are received by our passenger car every day that is not possessed by the iron, and the result is that under continual blows, the iron is damaged to a very much greater extent than

the wood is now damaged, and it would cost us a great deal more money to maintain it than the wood.

Everybody knows why they build iron cars in Europe. The reason is that they have not the wood there and they must build them of iron, and it does not matter if it does cost three or four times as much, because they have not got the wood, and that same condition will sometime confront us because the time will come when we will run out of wood, but that time is not yet here. I do not believe that we are yet ready for the iron car, because we can get timbers to build cars and can build good ones.

MR. KEEGAN: In support of the statement made by Mr. Forsyth, and in answer to Mr. Schroyer, we have had a quotation within a few days of $1,100 for a steel car that two years ago cost $1,325. I will say, further, that the operation of the Pennsylvania Freight Car Pool, which maintains all the freight car equipment on Pennsylvania Lines, indicates that an economy is produced in the matter of maintenance of freight cars through the use of the steel cars, from the fact that in the schedule showing number of cars to be rebuilt on the different lines composing the pool there is a reduction in the number of cars to be built this year of about 20 per cent as compared with the number requiring rebuilding last year.

MR. HENNESSEY: Just one word more. I do not think that the steel car has been with us long enough to make a fair comparative statement. It is not fair for a road that has been building steel cars for five or six years to be making comparative statements with wooden cars, some of which are twenty-five years old. That is where we do not get good comparative statements of the cost, try as hard as we may.

There is another thing in steel cars that I do not think is fully developed, and that is the advance of corrosion on steel cars. You cannot protect it with paint; where it laps on the corners it cannot be protected. If painted on the inside, the lading knocks the paint off and corrosion commences to work at once. Now, I believe that the steel car, as Mr. Schroyer said, is going to be here sometime in the future, and possibly we will have to use it universally, but I do not think it is good economy at the present time.

GEORGE WELSBY SCOTT: (Communicated). The paper by Mr. Seley recalls many considerations which I had in mind when designing the system of Under and Upper Framing for Cars described in the paper "Steel Framing for Freight Cars," which I was permitted to present to this club at its meeting in March, 1901. With that paper I submitted two drawings, one descriptive of the Under Framing, and the other showing an arrangement of Upper Framing involving Posts, Carlines and Braces of Steel of Commercial Sections.

For easy reference the two drawings show by isometrical projection, the general character of the respective framings. Fig. 1 disclosed a system of Under Framing which has been found successful in service of a rigorous character, and Fig. 2 illustrated a system of Upper Framing which has proven equally successful.

In Mr. Seley's paper he refers to the weakness ordinarily to be found in the end framing of box cars; and it was because of this known weakness, and the desire to provide a more competent structure, that the design illustrated was employed. An examination of the drawing will show the application of the diagonally disposed tensional members whose functions, operating in conjunction with the associated parts, it is to prevent distortion of the sides and ends of the body of the car. The said diagonal members are anchored to the under framing and connected with the upper longitudinal members, all as shown.

It is true that the use of a steel upper framing for a box car intended to be sheathed with wood involves a difficulty with respect to the application of suitable nailing pieces, but that, after all, is a detail and one depending upon the character of the steel framing. In the instance of the framing in Fig. 2, the application of nailing strips offers no special difficulty by reason of the simplicity of the upper framing itself.

With regard to the use of steel in the upper framing for baggage, postal and combination cars, some structural advantage will be derived by a proper consideration concerning the location of the doorway. An analysis of this phase of the problem will show that, other things being equal, the most advantageous position for the side doors is over the bolster, and the next best position is in the middle of the car length. Positions intermediate to these two being less advantageous and to an extent depending upon the location assumed.

THE CHAIRMAN: If there is no further discussion, we will ask Mr. Seley to close the paper.

MR. SELEY: My principal criticism of Mr. Schroyer is that he speaks of the use of iron instead of steel. I would not build iron cars myself, I would rather build steel cars.

As regards his objection to patents, I would say that it is a commercial proposition for a man, if he has an idea to get it patented, and a manufacturer will not object to pay him for that patent. Steel car companies have done the same thing; it is their right. We are buying any amount of patented articles for railroad service and we think it is the proper and right thing for the United States to stand back of the patent system of the country. At the same time I will say that I have never taken out any patents on the designs which I made while on the Norfolk & Western Road. There are two designs of hoppers, forty and fifty ton; forty-ton gondolas and forty-ton box cars.

As far as Mr. Hennessey's criticism is concerned in regard to eighteen months not being a fair trial of the design in question, I meant to draw the conclusion that eighteen months was a fair time to test the construction, as to whether the steel upper frame would carry the load and not bulge if made of light sections. I think that is absolutely and conclusively proved by eighteen months' service of these one hundred box cars. He speaks of successfully using steel in center sills. I am not absolutely sure that his sill is entirely of steel; my impression was

that you were using a form of steel draft gear rather than the complete steel sill.

MR. HENNESSY: The sill is an entire steel sill.

MR. SELEY: I happen to know of a road that has tried that before with a considerable number of failures, a large number of center sills were broken. I do not know of a single center sill being broken on the Norfolk & Western in the steel frame designs on that road.

In regard to Mr. Peck's assertion that a different class of men are required for repairs of steel cars, I would say that is not the case on the Norfolk & Western road. They not only repair the cars, but build them with the ordinary car labor.

I must confess that my experience in regard to the use of steel has been on the Norfolk & Western Road and not on the Rock Island. The Norfolk & Western R. R. is a coal carrying road to a very great extent, and to that extent those are special cars, although used in general traffic on that road so far as the gondolas and box cars are concerned.

I think that Mr. Schroyer has had some very high quotations, and I would not advise him to buy of the party that quoted them. While on the Norfolk & Western Road, as stated in this paper, we built one hundred steel frame box cars, and immediately followed with four hundred wooden cars of the same capacity, same trucks and same general dimensions. The wooden box cars cost about $140 less than the steel framed cars. As you know, that road is favorably located in reference to the Southern lumber market, and it is quite a haul from Pittsburgh, where the steel had to be obtained, and it did appear to me that if these cars could be manufactured closer to the base of supply of steel, that the difference in cost would be so far reduced that it could very well be disregarded.

Mr. Hennessy spoke on my side of the case when he spoke about the low cost of draft gear repairs when attached to the steel sills. As far as corrosion is concerned, I think that that matter has been overestimated in the West. I feel quite sure of it. We have had steel tanks on our tenders for years, and they have as severe service as any coal car, and while I have had no experience with all steel coal cars, I have watched them very carefully, and I will say in regard to the Norfolk & Western type, composite construction, that I have seen very little evidence of bad corrosion. I know there are coals in some sections of the country so loaded up with sulphuric acid that if allowed to stand in the car, the steel will corrode very badly. I do not know whether it was for that reason that the Norfolk & Western decided that the composite construction was better for their use or not; in any event, they have tied to that construction. There is very little steel in their cars that is in contact with the coal, and I have seen those cars all over the country and have watched them wherever I have seen them; they look at me, apparently, without my looking at them, and I have never seen one of them out of line, even with a full lading of coal.

I agree that so far as making a comparison between wooden and steel box cars is concerned, that the comparison is not favorable when figuring on a wooden upper structure placed on a steel underframe; in fact, I do not believe in that sort of construction at all, and I base my belief on the performance of the design quoted in this paper. They are so stiff, so free from any working of the body due to their construction; they are always straight up with their load; in fact, when they are down they are gone. The cars were a pleasure to me, and so far as first cost was concerned, the situation on the Norfolk & Western justified going to steel in every sense of the word.

We largely manufactured the cars ourselves, so that we saved the manufacturer's profit. Allowing 10 per cent profit, would not bring up the cost of these cars anywhere near the figures that have been quoted by Mr. Schroyer.

Regarding the economies of the cars, I feel sure that steel cars, whether of the type I have described, or steel underframed, or anyway that you will apply the steel, that steel is going to make a saving in maintenance.

I called attention in this paper to our weak box car ends, and I do not recall hearing anybody defend wooden construction in that particular. The Norfolk & Western have classified their repairs, and I recall that their No. 1 repairs on these steel cars contemplates a car thoroughly wrecked, such as its condition would be after rolling down those Virginia mountains. They would bring that car back to Roanoke, cut it apart, straighten the bent sections, rerivet it, renew the woodwork partially or wholly, repaint and restencil a fifty-ton hopper car at an average cost of $134.78. If you roll a wooden box car down those mountains you would leave it down at the bottom of the hill, burn it up, and possibly get the scrap back. The fact of the case is you cannot destroy that steel. An analysis of the $134.78 goes to show that 74 per cent of the amount is for labor, the balance for material. All of our wooden car owners know that the heavy repair costs of wooden equipment reverse those figures; you will pay your 75 per cent for material for the heavy repairs of your cars.

While I may be a little bit early in urging this matter of steel in general construction in the West, I have one point in mind that it might possibly be of assistance in the future. The Master Car Builders' Association has been working towards standards, and it seems to me that by the time that steel is necessitated in general car construction in the west, we may have arrived at a general design, or at least a design on general lines which could work in as a standard on western roads. Whether that is advisable or not, I do not know, but I had that idea in mind in bringing up the steel car question at the present time.

THE CHAIRMAN: Our next paper for discussion this afternoon is, "The Technical Graduate and the Machinery Department of Railroads," by Prof. W. F. M. Goss, of Purdue University.

THE TECHNICAL GRADUATE AND THE MACHINERY DEPARTMENT OF RAILROADS.

By Prof. W. F. M. Goss, Purdue University, Lafayette, Ind.

THE TECHNICAL GRADUATE of the better schools of engineering is not, as many people have supposed, a boy, but a man. His age may approach thirty years, and is never less than twenty. The average age of sixty-three members of the department of Mechanical Engineering of Purdue University is twenty-two. (See appendix.) The average graduate has good health, a good frame, and some muscle. As a day laborer he should be able to earn his wage. He also has some experience as a mechanic. In school he has had courses in shop practice which, while too limited to give him great skill, have served to enlarge his understanding of such matters. Many instances have come under my observation of men having no other experience than that afforded by the college shop, taking regular employment as machinists or pattern makers with satisfaction to their employers. Moreover, he has had a limited amount of actual shop experience either before entering college or during his summer vacation, or both before college and during his summer vacation. By the service sheet of the class already referred to (appendix), it will be seen that there are but two men in a class of sixty-three who have not engaged in some regular work at a stated rate of pay. The longest period of service is approximately nine and a half years; the average for the class is two years and two months. Most, though not all of this service, has been rendered in shops or drafting-rooms. His school training, also, permits him at once to do useful work in any drafting room. All these are very commonplace qualifications, but they are too important to be overlooked by anyone who seeks to formulate an estimate of the graduate's ability to serve.

The average technical graduate has some unusual qualities of character. As a youth he persisted in his school work when many of his fellows having equal opportunity yielded to boyish desires and dropped out to become wage-earners. The technical graduate held to his task. At the close of the grammar school the ranks about him thinned and again at the conclusion of the high school many of his remaining companions dropped away. But he kept in check his natural restlessness and entered resolutely upon the four long years of a college course. Nor has his part been entirely one of passive resistance. All along the way he has been subjected to severe tests designed to prove his worthiness to proceed. In the high school, at the entrance gate of the college, and throughout his college course, men have failed and departed, while he has passed on. Many of those who have proven themselves stupid, or lazy, or indifferent, or of bad habits, have been shaken out with the result, that whatever may be his faults or deficiencies on the day of his graduation, the fact remains that the technical graduate is a winnowed product.

Finally, the technical graduate in his knowledge of science and technology has a broad foundation upon which to build a life's work as an engineer. He is something of a scholar and is sufficiently trained in intellectual processes as to be able to deal with facts as he finds them. The technical graduate is usually exceptionally pure in his impulses and purposes. He knows how to sacrifice and is honest and truthful. In many cases he has earned much of the money which he has spent as a student, and as a rule, he is always ready to work. These in brief are his attributes.

In all this I have no wish to imply that the technical graduate knows all that he ought to know, or that his character is always perfect. In common with other men, he has faults. But no one should be judged by his faults. I am asking no favor in behalf of the technical graduate when I seek to have him measured by the standards which are applied to other men.

There are in this country approximately sixty institutions of recognized collegiate standing, having students in those departments of engineering which most closely touch the interests of the railroad, namely: In Civil, Mechanical, Electrical and Chemical Engineering.* In the year 1901-2 forty-eight of these institutions, embracing certain of the so-called land-grant college for which statistics are available, had in attendance upon the courses named a total of 9,084 students.‡ Full returns for that year would doubtless show a total for all institutions of between ten and twelve thousand. Of this number, not less than two thousand were graduated. Since 1902 the enrollment of students in most schools of engineering has materially increased, and the probability is that the number of graduates from the courses named will this year approach 2,500.

The absorption each year by the various industries of the country of 2,500 or more trained young men is a matter of no small signficance. It requires no argument to show that these men include in their number many who will later have a prominent part in advancing the engineering practice of our country, and, hence, their distribution is a matter of some importance. If, for example, it were shown that some one industry receives and retains in its service a much larger share of these technical graduates than another having similar needs, it would be expected that its operations would in the long run become the more efficient, and, similarly, it would appear that an industry receiving less than its share must in the end suffer through lack of technical ability. In view of these facts it is of interest to inquire whether the motive power and car department of railroads is getting and retaining its share of the technical graduates?

THE MOTIVE POWER DEPARTMENT AND THE TECHNICAL GRADUATE.—It is the experience of the college authorities that the number of graduates

*For complete list of institutions having courses in engineering, see Proceedings of the Society for the Promotion of Engineering Education, Vol. X, 1902.

‡Report of the Commissioner of Education, Vol. 2, 1902.

desiring to enter the motive power and car departments is small when compared with the number which the railroad officials ask to have recommended to them. To those who have been interested in specializing the preparation of the college man for the work of such departments, this has been the source of some disappointment. But the fault is not the student's, for the student of mechanical engineering is usually predisposed to enter the railroad service. Nor is it the fault of the college, for the success of courses in locomotive design, car design, and locomotive performance, as administered in the college, is shown by the comparatively large numbers of students electing them. Such subjects appeal to tastes of students and are chosen by them in anticipation of service which later they hope to render. But when the time for business comes they look the field over, and having ascertained something of the character of the various opportunities which are open to them, they generally turn from the motive power department and make their start elsewhere. Such a condition is in part due to the pressure of good times, and to the number and variety of chances which in recent years have presented themselves to the graduate, but it is none the less true that in competition the offer of the railroad has not proven attractive.

Another condition which suggests that the motive power departments of railroads do not get their share of the technical graduates is to be found in the fact that this department takes a smaller proportion of graduates in mechanical engineering than the maintenance of way department takes of the graduates in civil engineering. Basing a comparison on the last two classes which have graduated from Purdue, but 21 per cent of the mechanical engineers have entered motive power departments, while 55 per cent of the civil engineers have entered maintenance of way departments. It may be argued that as compared with civil engineers, the mechanical engineers have presented to them a greater variety of opportunities and, hence, that a smaller percentage of the whole number follow any one pursuit. But I fancy that the principal reason is that the inducements offered him by the motive power departments are less than those which are offered by the maintenance of way department.

Again, an examination of the pay rolls of railroad companies will show that the number of technical graduates of the apprentice grade in the motive power and car departments is not only relatively small, but actually so. On most western roads the number is less than one to each one thousand men employed, while many roads of considerable size have no technical men in training.

These considerations, while briefly stated, constitute strong testimony favorable to the contention that railroads are not getting their share of the technical graduates for their motive power departments. There are other considerations which at first sight seem to lead to a contrary conclusion, but which when analyzed are in fact not antagonistic to those already considered. To some of these attention may now be given.

A QUESTION OF IDEALS.—The ideal of the motive power depart-

ment discloses a two-fold purpose. On the one hand is the technical work which is the basis of all design, of methods in repair and maintenance, and of all those means which are employed by the expert engineer to insure freedom from failure and economy in action. On the other hand are matters of operation, or, better perhaps, of administration, having to do with men, and with all of those matters which are essential in securing their prompt and harmonious action. The one is the work of the engineer, the other of the business man. While any motive power department must perform both of these functions, it may within limits emphasize one or the other, and evidence is not lacking which shows a tendency in present practice to slight the technical and to emphasize the administrative. It can be shown that it is only on the larger systems that any considerable amount of expert work is asked or expected of the motive power department. Such work when necessary in the design of equipment or in framing the specifications governing its construction, is in many cases offered by the supply houses and accepted by the railroad companies. When unusual improvements are to be made, outside expert help is called in. Upon many roads the motive power and car department makes no real pretense at being a technical department, it merely represents one phase of operation. In so far as the condition described applies, the fact must be recognized that the motive power department under these conditions presents no large field for the technical graduate. His place is rather with the railway supply houses which are in effect the engineering bureaus of the railroads.

While it is undoubtedly true that the process which is responsible for the present practice has reduced costs, promoted standardization of equipment, and has proven in many ways highly beneficial to railroad companies, it may well be asked whether the provisions which serve for the work of today are likely to be sufficient for the practice of tomorrow. It will be well to remember that just at present roads are enjoying the services of thousands of men who, by virtue of unusual qualities of character, have risen from the ranks of the mechanic to high positions of responsibility in the railroad service. But the process by which these men have been trained is likely to be less productive in the future than it has been in the past. The aspiring youth of thirty or forty years ago who then turned to the shop for his training, would unquestionably have attended a technical school had the advantages of the modern institute then been open to him. The corresponding man of today is in most cases to be found in college. Moreover, the conditions existing in the shop a generation ago were more favorable to the development of men than those which exist in the modern shop, while the demands which are to be made upon the official of the future are likely to be made more exacting than those which are made upon the official of today. All this leads inevitably to the conclusion that no motive power department should fail to have its group of technical graduates in training for its future work.

One other condition which is sometimes urged as a reason for not

employing technical graduates is the difficulty which some roads allege to have in finding work for them after they have finished their special apprenticeship. It has been said by the superintendents of motive power of several roads that they had college men who had finished their probationary period, but no vacant offices to put them into. Obviously, so far as this may be a real difficulty, it constitutes an objection to the employment of considerable numbers of technical graduates. But is the difficulty real? If the technical graduate is a good man, there should be profitable work ahead. If he is not a good man, he should not have been tolerated through his special apprenticeship. Think of it! Here stands the superintendent of motive power at the head of a corps of several thousand men. He is responsible not only for its present efficiency, but for its development for future service as well. Down beside him is the college graduate who has served his time—one graduate and a thousand and perhaps fifteen hundred men who are not graduates. I am sure that no superintendent of motive power in this presence will wait for a vacancy before using the full strength of this young man. In looking over his organization, however strong it may be, he will see weak spots which ought not to be there; faults which may arise from the failure of a man, from the yielding of defective or of insufficient material, from a lack of a definite understanding of related facts, and having found the thinnest and least defensible spot in his whole organization, he will put his young man into it, perhaps merely as a multiplication table to a foreman whose practical training makes him valuable but whose figures are bad, perhaps as an inspector of material, or as a student of failures in materials, but whatever the task, he will feel sure that if he chooses well, the young man will earn his salary, and will at the same time be in training for the larger responsibility when it comes.

Notwithstanding the evidence to the contrary, therefore, are we not safe in believing that the motive power and car departments need the technical graduate?

THE SPECIAL APPRENTICE.—To the technical graduate the motive power and car departments of a railway offer two alternatives. He may enter the drafting room either in the capacity of a draftsman or with the expectation of soon becoming one, or he may enter the service as a special apprentice. If the former, his course is the result of purely business propositions. He finds the work and the wage properly adjusted one to another, and there is nothing in the whole process which is peculiar or which in any way calls for extended discussion. He is a workman, is recognized as such, and his opportunities for bettering his condition are subject to many of the limitations which apply to workmen.

The technical graduate who enters upon a special apprenticeship, by so doing announces that he intends to work for an official position on the road; and the company in accepting him, agrees to so train him that he may be worthy of such a position. In view of this compact, the special apprentice accepts a low wage, and the railway company undertakes to vary his task notwithstanding the fact that such a course limits for a

time the usefulness of the apprentice. On a very few large railway systems the course for special apprenticeships has been worked out with care. Students in such courses are handled with intelligence and consideration, with the result that they are satisfied, while the road accomplishes its full purpose in training men for its service. Most roads, however, undertake to receive special apprentices with no adequate understanding of their responsibility in the matter. It often happens that injustice is done the special apprentice and that in the end the road fails in its efforts to make him a means of strengthening its organization. Moreover, the unhappy experiences of those who have been through the mill, or have attempted its passage, have had their influence on the undergraduate with the result that it is now more difficult than formerly to interest graduates in a special apprenticeship. Such a condition is unnatural. It is unmerited by the technical graduate and is, I am sure, contrary to the real interest and desire of the management of our railroads.

In view of this, I venture to outline some of the defects which, as they seem to me, sometimes appear in the administration of the special apprenticeship and, in some cases, to suggest a possible remedy.

One defect is the low wage paid the special apprentice. He has depended upon others throughout his school and college course and has long looked forward to the time when he can begin to take care of himself. He is willing to deny himself many things; he will be content with rough clothes and scant fare, but except in rare cases, he must have self-support. This is not given him, as a special apprentice, and the opportunities of such an apprenticeship are, therefore, sealed against most graduates. It is only the man of means, or the man who is not very sensitive concerning the sacrifices which are being made for him at home, who can enter such a course. In effect, therefore, the railroad deliberately closes its doors to the rank and file of the graduates in mechanical engineering.

Some roads have fallen into the habit of receiving technical graduates, ranking them as special apprentices, and of then undertaking to see how valuable they can be made to the road, without much regard for the rights of the graduate. By this arrangement it is possible to secure a man for twelve or fourteen cents an hour, who can run a lathe, make a drawing, summarize statistics, conduct an experimental investigation, inspect material, report on defective equipment, test a locomotive, figure the bracing for a boiler, outline a scheme for motor-driving in an existing shop, install motors, or interview a division superintendent in behalf of his chief. When a road keeps such a man busy under the hardest sort of conditions, perhaps transferring him to a roundhouse or division shop remote from the center of the road's activity, when he has no contact with men who can aid him and few opportunities to observe processes which can instruct, the attitude of the road toward him is lacking in that element of fairness which is essential to permanent success. An organization in which such things are possible is obviously not ready for a special apprenticeship. It needs more than other roads per-

haps, the technical graduate, but it has no right to accept him as a special apprentice. It ought rather to take its technical graduates as it takes other men, not for the purpose of training them, but for getting service from them, and having them, they should pay them what they earn. I am glad to say that there are some roads which are now following this latter plan.

Another defect in the present special apprentice course is the long continuance of a deadly parallel. By the present practice all men are treated, or at least paid, alike, usually throughout their course. While I am a great believer in the buoyancy of youth, I know that it takes exceptional qualities of character to inspire a man to unusual and long-continued effort when his companion who makes no such effort, receives the same recognition as himself. I know that the difficulties which, in a railroad organization arise with this objection, are great. Nevertheless, for best success the system must individualize the man before he reaches the age of twenty-five. This the special apprenticeship fails to do. To remedy this either the rate of pay should be varied during the last two years, or the formal course should be shortened.

Again, underlying the special apprenticeship course as administered upon most railways, is a conception that the technical graduate must be made to overcome as many difficulties as possible. He is set to work with a gang of men unfriendly to his purpose and to him, he is often required to work under a foreman whose chief desire for the time being is to make him show a white feather. He is given the heaviest end of the lever and is required to keep lifting long after the necessity for effort has passed. As a rule, he does not complain, and it usually happens that the men who were factors in making his lot hard are among the first to start a song in his praise. But even though the process seems to work out successfully, it may not be wise. When one's task is made hard merely for the purpose of opposing him, there is something wrong. When the same form of opposition is many times repeated, when the apprentice is changed from one gang to another, from shop to roundhouse, and from roundhouse to special investigation, always in the attitude of defense, the process ceases to be disciplinary and uplifting. It tends to dwarf the man rather than to draw him out. Manufacturers in dealing with the same matter, have learned to handle it in a much more satisfactory way, their plan being to give the technical graduate official recognition from the beginning.

I am sure that no one will accuse me of desiring simple ease for the technical graduate. My plea is not that their task be light, but that they be given such reasonable opportunity as will make their position attractive to the average man. In urging this plea, I assume that I am serving the railroad companies quite as much as the technical graduate.

Finally, as opposed to much of the criticism which I have urged, it is sometimes said that even though the work of the special apprentice is unremunerative and difficult, his reward is sure and in the end sufficient. But is this true? I know that popular sentiment or fancy lends a halo of brightness to the official position of the railroad, but the time

has long since passed when sentiment could be made an important factor in a business contract. Is it true that the degree of official recognition which awaits the average technical graduate in the railroad service is greater than that which awaits him in the service of corporations of other sorts, and if it is not true, is it good policy on the part of the railroad corporation to make its early work less attractive than that of other corporations?

APPENDIX.

AGE AND SERVICE-SHEET OF 63 SENIORS IN THE DEPARTMENT OF MECHANICAL ENGINEERING OF PURDUE UNIVERSITY.—In obtaining the facts which are given below, slips of paper were distributed to all members of the class, with the request that they give thereon their name, their age upon graduation, their business experience, if any, and the total period for which service had been rendered for pay. Business experience was defined as regular service for which pay at a stated rate had been received.

In making up information thus obtained for presentation herewith, names have been omitted and the description of the nature of work done has been greatly abridged. Accuracy cannot be vouched for, but it is fair to assume that the statements are substantially correct. The total number, 63, is nearly, though not quite, the full enrollment of the graduating class in Mechanical Engineering. It represents the full number who were present at the time the information was called for. The statement is as follows:

		Total service.	
1—Age 22.	Machinist, B. R. & P. R. R., and for Rochester Electric Motor Company	3 yrs.	9 mo.
2—Age 24.	Machinist, teaching and farming	2 yrs.	9 mo.
3—Age 22.	Farming		10 mo.
4—Age 20.	With C., M. & St. P. R. R. as chainman and stakesman, Draftsman American Bridge Co.		6 mo.
5—Age 24.	Drafting for Union Switch & Signal Co., clerk in county auditor's office and in bank	1 yr.	6 mo.
6—Age 26.	Apprentice and journeyman machinist, office assistant, stock-room keeper	8 yrs.	
7—Age 20.	Running engine and general work for Chas. W. Brizius & Co.	1 yr.	
8—Age 25.	Teacher, machinist, draftsman for the Ohio Brass Co. and for the N. C. & St. L. Ry.	1 yr.	6 mo.
9—Age 23.	Machinist, Corwell Apparatus Co.		3 mo.
10—Age 22.	Bookkeeper, Mundle Bros., R. H. LeBlonde, American Tool Co., Virginia Hotel	3 yrs.	4 mo.
11—Age 22.	Toolmaker, American Tool Works Co. and the Wm. Beson & Co.	1 yr.	6 mo.
12—Age 20.	Machinist, draftsman and tracer		7 mo.
13—Age 24.			None.

		Total Service.	
14—Age 22.	Wood-working, Estey Mfg. Co., machine shop Owosso Sugar Co.	1 yr.	9 mo.
15—Age 23.	Machinist apprentice and journeyman	6 yrs.	
16—Age 23.	Surveying, drafting for C., B. & Q. R. R. and concrete work for National Bridge Co.		10 mo.
17—Age 23.	In Pullman machine shops		3 mo.
18—Age 27.	Bookkeeper and salesman, wholesale grocery, storekeeper and master mechanic's clerk and draftsman Union Iron Works, foreman with U. I. W.	6 yrs.	9 mo.
19—Age 20.	Machine hand in wagon shop		9 mo.
20—Age 22.	Bookkeeper and time clerk for general contractor	1 yr.	2 mo.
21—Age 25.	Wagon-making, bookkeeping, machinist and draftsman for Telephone Co.	2 yrs.	11 mo.
22—Age 23.	Telegrapher, shop work, test work		3 mo.
23—Age 22.	Machinist for A. L. Ide & Son		3 mo.
24—Age 22.	Drop Forge Co.		5 mo.
25—Age 23.	Foundry work, Brown & Ketcham		2 mo.
26—Age 21.	Machinist, P., F. W. & C. R. R. and in erecting shop		9 mo.
27—Age 22.	Draftsman for Alfree Engine Co.		3 mo.
28—Age 25.	B. & O. R. R. shops		2 mo.
29—Age 24.	In hardware store, wood-working for Columbia School Supply Co.	8 yrs.	
30—Age 24.	Draftsman, Monon shops, clerk in mercantile house	3 yrs.	9 mo.
31—Age 22.	Machinist, P., F. W. & C. R. R., engineer, fireman on steamer, conductor for Electric Ry. Co.		6 mo.
32—Age 23.	Grocery store, machine dept. of M. C. R. R.	2 yrs.	
33—Age 26.	Purchasing dept. American Tool Works Co., full apprenticeship with Laidlaw-Dunn-Gordon Co.	4 yrs.	6 mo.
34—Age 25.	Machine apprentice, Chicago & N. W. Ry., machinist, G. & G. N. Ry., draftsman, C. R. R. and for N. Y. Central Ry	3 yrs.	6 mo.
35—Age 22.	Machinist, engineers' asst. and toolmaker	1 yr.	3 mo.
36—Age 22.	In air-brake room of Mo., Kans. & Texas, clerk office real estate and insurance	2 yrs.	3 mo.
37—Age 22.	Testing, office work, carpenter work and farming	1 yr.	10 mo.
38—Age 21.	Architect's office, automobile mechanic and clerk in bicycle business	1 yr.	8 mo.
39—Age 23.	Draftsman and with Muncie Gas Engine & Supply Co.		6 mo.
40—Age 23.	Draftsman, repairing, assembling, erecting and shop work	2 yrs.	3 mo.

		Total Service.
41—Age 25.	Machinist for J. B. Alfree Engine Co., apprentice B. & O. erecting shop........................	5 mo.
42—Age 22.	For S. Pacific R. R. ,shops of Norfolk & Western, Virginia Bridge Works	3 mo.
43—Age 21.	Erecting Floor American Bridge Co., Machinist Sterling Co.	2 yrs. 1 mo.
44—Age 24.	Mechanical Dept. Western Steel Car & Foundry Co.	1 yr.
45—Age 24.	Sterling Electric Co.	3 mo.
46—Age 22.	Machinist apprentice and machinist Rodman St. Ry., Carnegie Steel Co......................	3 yrs. 4 mo.
47—Age 27.	General contractor, apprentice and journeyman in tailoring shop, bookkeeper, school teacher, coal mines	7 yrs. 8 mo.
48—Age 20.	General work on ranch and machine work, Stirling	8 mo.
49—Age 25.	Machine shop	4 yrs.
50—Age 24.	Apprentice in manufacturing plant and Deans Pump Works	6 mo.
51—Age 23.	Lake Shore Shop and Drop Forge Co..........	6 yrs. 10 mo.
52—Age 25.	Draftsman Baldwin Locomotive Works and American Hoist & Derrick Co., engine and electrical design	3 yrs. 6 mo.
53—Age 21.	In a foundry	3 mo.
54—Age 23.	Shop work	6 mo.
55—Age 20.	Drafting for different firms..................	1 yr. 3 mo.
56—Age 20.	Collector and work in laboratory of Illinois Steel Co.	2 yrs. 3 mo.
57—Age 21.	....	None.
58—Age 25.	Draftsman Dodge Manufacturing Company and in patent office	4 yrs. 4 mo.
59—Age 29.	Treasurer's office, Denver, Surgical Supply House, Engineer Department City of Denver, Operating Department for Chief Engineer Colo. & Ry............................	9 yrs. 5 mo.
60—Age 24.	Paper Co., plumber apprentice, wholesale hardware and for different factories..............	4 yrs. 7 mo.
61—Age 22.	Shop work	1 yr.
62—Age 25.	Bookkeeping and business for self............	5 yrs.
63—Age 24.	Machinist Kingan & Co., Atlas Engine Works, Dean Pump Works..........................	7 yrs.
Average 22.	....	2 yrs. 2 mo.

THE CHAIRMAN: Gentlemen, the paper is before you for discussion. We have one or two written discussions, which the secretary will read.

GEORGE WELSBY SCOTT (Communicated): In his paper Professor Goss has graphically described what may be termed the formation, growth and development of the technical graduate. The paper is an analysis, as it were, of the student's career and it tells us much that is profoundly interesting and instructive because of the many sided phases of the subject presented to us by the Professor.

No one can read the paper without being deeply impressed with the rigorous character of the process to which the student is subjected. And as Professor Goss so clearly tells us, the student, in the final analysis, presents an object lesson of one who has been persistent, active and unswerving in the pursuit of knowledge, and one who, at the last, is an illustration of the survival of the fittest, the weaker, incompetent, and unfit ones having been dropped, or passed, on the way.

We are also told that the average age of the graduate is 22, and that he "Has good health, a good frame, and some muscle." Along with this, we may assume, is the possession of a trained mind and the ability to think, and to think along definite lines to an equally definite end.

Qualities like these would appear to be of especial value to the motive department of a railroad; and yet according to Professor Goss, the larger portion of the graduates are to be found in the service of manufacturers and supply houses. That there is need in the motive power and car departments for this combination of physical and intellectual qualities must be conceded; but the need is not the only governing factor in this consideration, and due value must then be accorded other features, not the least of which is the purely personal one of the individuality of the student and the personnel of the existing organization which he seeks to enter.

College life is a world of its own. It is a life into which the student enters with profound respect, and from which he emerges with a diploma and a measurable degree of assurance as to his having acquired a knowledge of all that is contained in his particular study. It would be strange, indeed, if things were very different in this respect. For has not the student passed his examinations? And in his later years has he not stood superior in attainments to his younger fellows? And is it not a fact that throughout his college life he has been excluded from the shocks and jars incidental to business life and its stern necessities?

The situation, then, is pretty much one in which the student, strong in his conviction of the possession of knowledge, and, it may be, with a half expressed intimation of his superiority to the common order of things, discovers that master car builders and superintendents of motive power are not usually made in a day, or upon a mere application. He finds that there is usually much routine to be observed and a long course to be pursued.

The graduate may, or may not, realize all this in full, but he early

recognizes the fact of a perceptible barrier. The world, for a time, seems less kindly than before. Those to whom his application is addressed do not seem to accord to him his own measure of his own fitness. They do not enthuse as one might be expected to do in the finding of a particularly bright diamond or a nugget of gold large in dimensions. On the contrary, they coldly ask him what experience he has had; and to this he may reply: "Why, of course, I had the shop experience at X. Y. Z. University, and I made the drawings for the shop lathe and planned the power plant." Asked further, "But what practical experience have you had in locomotive or car work?" and he will probably reply: "While I have never been concerned with these things in actual shop work, yet I feel confident that I can take care of the situation."

The foregoing is surely no exaggeration, for it is a common experience with those having to do with such matters. Usually the graduate, if engaged at all, is given a position fairly well down the line, and the future is before him. In course of time he realizes the importance of actual experience; and with this awakening is a marked softening with respect to his earlier claims and assumptions, and later on he becomes the strong, capable one that he deserves to be.

As we have seen, however, the larger portion of the graduates find place with manufacturers and supply houses, and I am inclined to think that this is not so much a matter of selection as it is an expression of movement along the line of least resistance. Railroad corporations and their organizations are, as popularly supposed, things of slow movement, and much given to a retention of existing processes and procedure. On the other hand, supply houses are more ephemeral, versatile, and ever ready to change methods and tactics. Moreover, the personnel of a railroad is well nigh infinite compared with the few people associated with the average individual supply house.

The student thus discovers—either directly, or indirectly—that the railroad does not offer the immediate field for his activities which is afforded by the manufacturing and supply business. He further learns, or is led to believe, that in the matter of remuneration for his services the advantage appears to be in favor of the supply business. Some there are who are proof against the seemingly discouraging prospect on the one hand and the alluring activity and monetary consideration on the other, and the passing of events show the wisdom of such step in not a few instances.

It would seem, then, that the employment of the technically educated is a matter that is subject to much the same influences governing the selection of employes in other walks of life. For it is not so much a matter of being technically educated or learnedly competent as it is whether this or that one wishes to engage the aspiring graduate. Given an administration in which the executive is one who by his own ability, or by his knowledge, is in a position to judge of the unending commercial advantages of having those about him and with him technically trained, and the chances are that the educated ones will be in evidence

all along the line. Similarly, if the executive is one who by nature and disposition fails to appreciate the sterling advantages of a well organized band of trained minds and activities, it is not likely that the graduate would be favorably received or encouraged.

However, the situation at the worst is not altogether hopeless, for even in the case of those who do not take advantage of the light of learning and ability there comes a day when failing to take the initiative they must, perforce, adopt some of the measures of their more sagacious and able compeers or else become numbered with the incompetent and unprogressive. Meanwhile, the graduate will learn to modify his expression of assumed knowledge and superiority; he will be taught that all that he can possibly learn at college is but rudimentary to the larger life beyond, and that until he has fortified his acquirements with realities and experiences, he is still a student.

L. P. BRECKENRIDGE (Professor of Mechanical Engineering, University of Illinois): I have carefully read the paper presented by Professor Goss. The subject is one on which I have felt the need of a paper for some time. I am glad I did not undertake to prepare one, because it has been much better done by Professor Goss than it would have been by me.

I wish to heartily concur in what has been said. I wish to emphasize the statement made that "the technical graduate is a winnowed product." He is capable of doing more things and doing them better than he is sometimes given credit for.

Students in mechanical engineering about to graduate are continually asking advice as to what they had best do, and I am frequently asked: "What are the opportunities in railway work?" In reply I am bound to say, from an experience of twenty years, about as follows:

(a) The pay offered by the railroads is not as much as that offered elsewhere; (b) the chances for advance in pay and position are not as many as elsewhere; (c) very few roads will make any definite proposition as to opportunities beyond the term of special apprentice; (d) I have in mind several good men that stuck to the special apprentice work through three years; at the end of that time they were offered places worth only $75.00 to $90.00 per month—no more than men of their grade are offered at the time of graduation by manufacturing interests.

During the last few years the positions offered in the various manufacturing industries, together with the better pay offered, have caused the best men to seek employment there. I hope the railroads will not judge the product of the technical school by the men they have been able to get during these years of better times.

The practice of numerous progressive engineering and manufacturing companies of visiting the leading engineering schools in order to inspect the yearly supply of graduates is very suggestive. Why not inspect the brains you purchase, as well as the boiler plate and other supplies?

There seems to be a tendency on the part of the roads to undertake more and more the design and construction of their equipment. If this should ever become at all general, it would open up a large field for mechanical engineering graduates.

THE CHAIRMAN: Gentlemen, we would like to hear from you on this subject. Mr. Seley will you open this discussion?

MR. SELEY: I have been very much interested in Prof. Goss' paper and believe that the time is coming for a greater utilization of the college graduate. There is no question but that the methods in the shops as regards the advantages for ordinary apprentices are such that we are not turning out nowadays mechanics that are comparable to the old time all-around mechanic. We used to be able to have men that we could put anywhere in the shop, the machine shop, or erecting shop, or wherever needed, and they could do their work. To-day we have gone more to specializing, and although we take apprentices and put them through the shops they do not have the advantages that the men used to, and for that reason there is no material in any one man in the shop from which to select men for advancement as in the old times. It is getting more difficult all the time to get foremen and men for the advanced positions on the railroads, even for the highest offices. When we hear of a vacancy at the head of the Motive Power Department of a great road in the country, how many men are there available for that position that can handle it at once? And the same all the way down the line. I think that the technical graduate is the man who will, in years to come, be more and more employed in motive power work in the advanced positions. I cannot see it otherwise.

The Professor has drawn rather a hard picture of the lot of the technical graduate to-day. I have no doubt that it is true in some cases, but I believe that as the necessity for technical training finally works itself into the inner consciousness of our railroad managements, as they finally realize the quality of the men that they are turning out in their shops for the advanced positions, and all that, that the technical graduate will be able to find work on the railroads without the difficulties which hamper them at the present time.

So far as I am concerned, personally, I did not have the advantage of a college education, and it has caused me a vast amount of work, anxiety and trouble at times to satisfy myself absolutely that I was right. Very often we want to make a calculation, and if we have not had the training in higher mathematics, we must use a hand book formula which may or may not be correct. The college man, if he remembers his college training, can derive that formula himself, and he will have the confidence behind him of doing his work correctly.

There is no doubt that a great many college men think that they know a great deal more than they actually do. I think that is true of youth generally. I know that I looked up some things that I wrote when I was twenty years younger than I am, and I wondered now what I could

have been thinking of when I wrote them, and I imagine that the college boy when he turns out his first work thinks it is pretty good. I had to walk six miles at night to get my mechanical drawing, and I worked awfully hard to get it. When I had the chance to go to work in a drawing office, I made drawings that were used under some difficulties, but I remember very well that after I had been there two months, I looked up that drawing and tore it up; I did not want to have it in evidence. We learn how to do things and we learn how to train our minds, and we learn a lot of that work in schools and colleges, but we have got to learn actually how to do the work in the shop and in the office, and college training is no detriment to us; it is a mighty good thing to have, but it depends very largely on the individual.

I had the pleasure of attending a dinner in company with sixteen men, about half of them were successful railroad men, the other half were successful supply men, and about one-half of each half were college men, and the others were not, and every man had to tell his experience. The consensus of opinion, after the experiences had all been told, seemed to be that it depended upon the individual. That if a man was a fool, college education would not save him, but if he was a bright fellow, he would be all the better off for his college education.

MR. G. L. WILSON (F. Cortez Wilson & Co., Chicago): Prof. Goss has raised one question in particular which I think ought to be answered in a way. "Why does a larger percentage of the civil than mechanical engineers go into railroad service?" To my mind the reason is that the civil engineer does not have so many openings outside the railroad service as do the mechanical men. The civil engineer if he wishes to go into business, is pretty nearly limited to certain classes of contract and structural work, and if he does not go into that, he takes up certain classes of definite engineering work, therefore his line of least resistance leads to the civil engineering part of railroad work or maintenance of way.

I have told a great many young fellows looking for a start in the railroad business—I only touch it on the edge, but meet a lot of them—that if I was bound to go into the railroad business and could not get in anywhere else, if I could find a decent section foreman somewhere I would start on the section, simply because a reasonably bright fellow can push ahead faster there than he can anywhere else, as he will "shine" on account of his surroundings, and he will sooner arrive at a place where he really will be in charge of something. If he knows what he can do, if it is in him, it will come out very much faster there than anywhere else.

Perhaps the special apprentice is not appreciated by the average man in charge of work—that is the same in other places as it is in railroad service. I think from some investigations I made some years ago, that in part it is because the average technical school—if such a thing is not a bull—gives an undue amount of emphasis to the technical phase of the

student's course. He is taught throughout his technical course to ignore the administrative and business end of his coming vocation.

A good many years ago a young man with whom I corresponded and who has since made a great success in his line, was at Cornell. I was at that time interested in what might be called a scientific investigation of the subject of costs—the cost of production. It is a subject which has received much attention and is becoming more carefully analyzed every year, it is commanding the attention of good specialists at this time, but I asked him what text books, if any, were used at Cornell, in any of the engineering courses relating particularly to this question of costs. He wrote that they had none. I asked him to kindly take it up with the professors in the different departments and ask what they knew about text books, or articles, or anything about costs, which might be in the library. He became interested, went to the professors, librarians and various other people, but his search was fruitless; there was nothing available at Cornell relating particularly to costs, and his letter to this effect concluded with the statement that they regarded this as a purely collateral subject which would develop as a man got into his work. Well, that is what is the matter with costs; people have been going along, waiting for the subject to develop, and the average concern goes broke while it develops, unless it is developed as carefully as any other phase of the business. I replied to this young man that it seemed to me that if the students were there for anything, they were there for the purpose of acquiring technical information. They were there for the definite purpose of learning to do things more quickly, or better, or in some other way advantageously, and the net result must be computed in dollars and cents. They were in no sense idealists, they were there to produce earnings all the time, and if an employer taking the technical graduate into his institution could not feel that he was taking a step in the direction of better earnings he would stick to the man who has had some training in the administrative part of the business, perhaps with somewhat less technical training. When technical service is needed he will send outside for a specialist and pay for him. I believe that is largely what is the matter with the technical graduate. It is possible that some colleges have taken a forward step from the position just indicated as this was some years ago, but I do not believe they have gone as far along that particular line of administration as they ought. I do not mean to exhaust the subject, I mean to indicate to these students as they are acquiring elementary technical information, the necessity for the elementary capacity to reduce that to concrete shape, and to figure out when they are done, in dollars and cents, just exactly where they stand. That, to my mind, is the great thing that the average technical graduate must acquire. He has gone so far along this other road, regarding matters that he has to deal with simply as things, that he does not realize the definite connection between those things and the net result at which he has to arrive, which is "how does it figure out on the cost sheet," that is all there is to it, the net result.

Prof. Goss has drawn, perhaps, an unfair distinction here between the technical graduate and the fellow who has acquired a certain amount of information, but did not graduate. Unfortunately for me, I was one of those who did not secure the technical college education, but on leaving High School avoided some pretty good jobs that were offered, went to work as an apprentice in a machine shop, and studied nights. It kept me out of mischief, which was no doubt a good thing for me. There are a great many men who have done the same thing and they have acquired a considerable amount of technical education, the kind they need in their business, and a whole lot of rubbish they do not need, that is, it looks like rubbish on the surface, because each goes along the wrong line for a long time before he quits, still those men work right along with the college graduates.

If you will watch them, the special apprentices do not receive any treatment different from the other apprentices. Any boy who starts in a shop, office, or store, has the hard knocks just the same; if he starts on a pick-up wagon for a wholesale house here in Chicago, he "gets it" worse than any special apprentice in a railroad shop. If he starts out as an ordinary apprentice in any shop, he "gets it" all the way through, and this brings up another point in which the colleges fail. It is not so much the technical education which a man acquires that will be the determining factor in his success, as those other elements which have to do with success, whether he be a salesman or in any other calling that has to do with men. There are just two things that a man must have developed to a point where they will really do some good, make him noticeable and give him persuasive qualities when dealing with others.

One thing, of course, is health, and the man who can go through a technical college to-day has it, as a rule. The other is character. Does the average college aim, as definitely as it should, to develop that part of a man's makeup, that is, the individual personal character? I mean all these things which go to make a man all the way through, all the time, the things that make him a power, that is character. It is a big word, it takes in many things, you cannot analyze it very much, but too many of our technical graduates have to develop true character after they are out and begin to get these hard knocks. It is the hard knocks which have developed the character of many of them, exactly as those knocks have developed the rest of us. The fellow who has character will rise above these petty annoyances and put the men who have attempted to block his way in such a position that they cannot but admire him and change from a position of enmity into one of active support, even though their support may help to carry this man to a position over their own heads. Therefore there cannot be too thoroughly instilled into the minds of these technical graduates just two things, the relation of character to their ultimate success and the relation of their technical training to concrete results in dollars and cents. These two matters are not mentioned in Prof. Goss' paper and as the report of this

discussion is likely to have more or less circulation among the young men who are particularly considered in this paper it seems desirable that they receive at least passing consideration.

MR. FORSYTH: Mr. Chairman, this subject has been discussed by our railroad clubs before, and by technical papers, but I do not think it has ever been presented in such a masterly way as it is in this paper to-day, and I think it is unfortunate that the Western Railway Club has not held more of its members here and that we have not had a larger attendance to hear the proper discussion, or at least, to show their appreciation of this very important subject.

Professor Goss has an intimate acquaintance with these men, he has followed them through their college course and he has followed them afterwards in their business career, and he is in a position to give us a thorough account of them, as he has in the paper, but the principal question is, after they have graduated, what to do with them, and what shall the railroads do with them?

It is a disappointment and it is a surprise to find the statement in the paper here that perhaps only one of a thousand of the men employed in the machinery department of the railroads is a technical man. The causes for this have been given in the paper as low wages, one of the principal things, and another that the graduate is not given a reasonable opportunity and the position is not made attractive. Now, the cause of that, I believe, is in this so-called special apprentice course; that is one of the causes, that it ends at the close of three years and does not follow out the scheme, to find some use to make of this man, after he has had a technical education, after they have gone to the trouble of giving him a practical education, then there is no place outlined for his future career. That is largely the fault of the operating officers and a part of our railroad organizations and motive power men, or master mechanics, have not taken enough interest in following out this course. Prof. Goss says, the course as it is now would better be abandoned and let the man enter railroad service the same as any other workman and on his own merit, rather than under the present method of hiring him for three years at low wages and then let him drift into some other kind of work. What I have to suggest has been used on some roads, but not very generally, to have the positions of assistant foreman and of assistant master mechanics and assistant shop superintendents and positions of that kind where these men, after they have had their three years' training as mechanics, can get some experience in the management of men and thus be in training for higher positions, which they could better fill after having filled such subordinate positions, and where the salary and importance of the position will be so attractive as to retain them in the service.

In regard to the teaching of costs and estimates in schools, I think that the technical schools at present are, if anything, too technical, and

it would be unfortunate if they were made commercial. There are plenty of commercial schools, and the training that we want at college is that of mental application and of steady training of the mind, where the commercial element certainly should be avoided. That comes soon enough in after life, and can be taught in a pretty short time, but I think it would be unfortunate if the technical schools were to spend very much time on commercial training. They take up political economy and contracts and things of that kind, but as to figuring costs, I do not see that it has much place in the technical college.

E. H. SYMINGTON (Railway Appliances Co.): I want to say a word for special apprentices, for the simple reason that I have been through that mill and know what sort of row they have to hoe. I grant to this gentleman on my left that when a man gets out of High School, or from whatever he graduates that the very first thing he gets when he starts to work will be some hard bumps, and if he could get those bumps in advance, he would be of a great deal more use to railroads at the outset of his career. What I want to bring out is the fact that there is no question but that the railroads, like the large manufacturing interests of to-day in our country are going ahead, and the sucess of this country, in trade and everything else that is done, is based largely on the standard and the ability of the men who are doing the work of the varied industries in the country. A man does not have to be in railroad work very long before he appreciates the fact that there is a great deal to be accomplished in every line that he tackles and he becomes acquainted with the fact at once that what is needed everywhere are men of character and ability who can manage men and be organizers.

A great thing in favor of the technical graduate is simply this, that he has been taught application, he has a good fund of knowledge and if he has both feet square on the earth, the chances are that, other things being equal, he will go ahead and be of still greater use. However, if you take a good, bright mechanic who is industrious and has an ordinary education and put him at the bench in the shop with the technical graduate, who has an idea that because he is a technical graduate, he can do everything better than the mechanic, the mechanic is going to win out every time. The great thing from the standpoint of the technical graduate, as far as his ultimate usefulness is concerned, is that he learns and acquires a knowledge of men and of human nature, and there is no question but that our great men of to-day and the great men of the past have been men who have had a thorough knowledge of men and men's work, and the only reason that the technical graduate has an advantage over the other fellow is because his brain is trained and he has adaptability and knows how to apply himself to new and concrete problems when they arise, besides having a thorough knowledge of men.

G. A. DAMON (Arnold Electric Power Station Co.): The discussion of Prof. Goss' very interesting and timely paper has thus far been devoted largely to analyzing the qualifications of the technical graduate, but it seems to me that a very good opportunity is offered to discuss the

other side of the case, that is, to analyze the man who uses the technical graduate.

That "a great deal depends upon the man" is as true of the man who desires to get the best there is out of a technical organization as when applied to the technical men themselves. If an organization has at its head a man who thoroughly appreciates the value of technical graduates, then we have a fortunate combination which will result in developing the young technical graduate into a good all-round man.

The process of producing a thoroughly competent man, trained in practical work, and at the same time equipped with a technical education is a long one, which has only begun by the time a man completes his college education. To his college course should be added a comprehensive experience, and one of the weak spots of our present method of training men is that we have not yet developed a definite policy in connection with giving the technical graduate the practical experience which he should have.

In the course of my work in connection with the electrical equipment of railroad shops, I have had occasion to become acquainted with a number of technical graduates employed by various motive power departments, and therefore I know something of the troubles these young men have experienced in getting to the front. A number of them have dropped out, but this does not indicate that they were failures because they immediately found positions in which they were better appreciated, and were given a better chance to show what they could do. This means that the manufacturing companies are realizing the value of the technical graduate, and are giving him every opportunity of developing himself, and thus raising his value.

I believe that the technical man of the future will get as much assistance in laying out his course of practical work from men who are capable of advising him as is now given the college student in selecting his technical studies, and I am thoroughly in sympathy with any movement which will result in outlining some comprehensive system which the technical student will not only be expected to follow, but will have a right to expect in getting hold of the practical part of the business.

F. VON SCHLEGELL: As a technical graduate I want to protest against the theory that a technical man has to be fed with a spoon. The important things which a technical graduate has to learn is the practical methods of construction, and how to deal with men.

The trouble with the special apprentice is the word "special," and the assumption that he is to have a better position than the others, and that he is not in competition with the men who are there to make a living, but that he has merely to learn how the machines are made and run. I think he would complete his development quicker by starting out to make his own living at once, for there will always be a difference between the men who look at work as a school or luxury, and the men who find it a necessity. Furthermore, many of them feel that it is more important to acquire a certain skill than to learn the advantages and cost

of different methods. The reason that there are so few technical graduates in the mechanical department of railroads is that there is very little of the technical or mathematical part of railroad work which cannot be learned by a practical man from his formulas, as well as a technical man will be able to supply them if he ever gets to the point where he will be able to use them. The practical man has a further advantage of being able to supply correct data. Railroading probably attracts Civil Engineers rather than mechanical, for the reason that they see an opening requiring technical training either in the drafting department or the field where they will soon be able to earn a salary in the line of work they prepared for.

When a graduate in mechanical engineering enters the mechanical department of the railroad he should do so as a man in competition with other men and form his own ideas of what he wants to learn, for he surely must have some ambitions for the field after having chosen it, and studied for four years, and what he wants is to get a chance at the ladder, and it should not be necessary for any one to lead him clear to the top.

THE CHAIRMAN: Gentlemen, this is a very interesting subject and we are having a good discussion. I would like to hear from others. If there is no further discussion, I will ask Prof. Goss to close.

PROF. GOSS: I think I agree with most that has been said in the discussion of my paper.

I realize that in putting the technical graduate on a pedestal and offering him to you as a fair mark to draw the fire of the Western Railway Club, I place him at some disadvantage. I imagine that if anyone in this audience were set upon such a pedestal that we would not all be entirely satisfied with him, and yet I know the fact to be that all here are very able and excellent gentlemen

The technical graduate is not a perfect man in every particular. I have not claimed that he is perfect. I merely say that he is a man, that he knows a few things, that he possesses some experience and a great deal of that quality which has been spoken of as character. I have no plea to make in behalf of the technical graduate. I do not think that he is in especial need, but I present an argument tending to show that a great branch of the railroad service is not getting as many technical men as it ought to have, and have endeavored to show the reason for it.

I wish it to be understood that I have no objection to the things which you give the special apprentice to do, provided he is paid for doing them. I do object to a system which assumes that a large portion of the return he is to have for his time is to be in variety of experience, and then withholds the variety.

It is a mistake to assume that the college is for the purpose of training men to do a large amount of applied work. The college training deals with broad principles, not with detail. There are five hundred things which might be taught in college which are not given a place there. Not because they are not good, but because for the purpose in

hand, other things are better. Consequently, there are many things that the college graduate does not know, but if given a chance, he will find them out.

In conclusion, I must add a word of caution. There are many men about me in this audience who have not had the advantage of a technical training, and who are nevertheless leading a life of professional success which equals and perhaps exceeds that of many college graduates. But they do this, not because the omission of the college has helped them, but because they are exceptional men. Some men can not be downed, and whether they are helped or opposed, whether they are trained in school, or denied its advantages, they attain and make use of their attainments, and so grow in the fullest and largest sense in which that term is used. Many men of this class have made themselves men of education even though they may never have seen the inside of a college. But they have done this because they are men of exceptional qualities of character. It is not the fact that they have remained out of college that has made them great.

Adjourned.

The David L. Barnes Library

Special Notice.

The David L. Barnes Library of this Club, at 1750 the Monadnock, Chicago, is open for the use of members and their friends, and we hope it will be used freely. It is open on week days from 9 a. m. to 5.30 p. m., except on Saturday, until 3 p. m. Books must not be removed from Library, but the Librarian will assist visitors in finding information and will promptly reply to letters from out-of-town members desiring information from the Library. Donations of books and technical publications will be gratefully received.

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OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday, April 19, 1904, Mr. Le Grand Parish, vice-president, in the chair. The meeting was called to order at 2 p. m.

Among those present, the following were registered:

Atkinson, G. W. P.	Duntley, J. W.	Maus, N.
Ault, C. B.	Duntley, W. O.	McAlpine, A. R.
Averill, E. A.	Farmer, G. W.	McCarthy, J. J.
Ball, H. F.	Fenn, F. D.	McIntosh, Wm.
Barnum, M. K.	FitzGibbon, J. W.	McLeish, W. J.
Bennett, F. F.	Fitzmorris, Jas.	Midgley, S. W.
Bentley, H. T.	Fry, Jr., C. H.	Mileham, C. M.
Bickel, A. M.	Gilbert, E. A.	Mills, Geo. F.
Bischoff, G. A.	Giroux, Gustave	Morris, A. D.
Brandt, F. W.	Goehrs, W. H.	Morrison, G. D.
Brenneman, H. N.	Graham, J. A.	Owen, Elmo.
Brooke, G. D.	Haig, M. H.	Parish, Le Grand
Brooks, P. R.	Harty, J. W.	Patterson, J. B.
Carney, J. A.	Hill, Jas. W.	Roach, J. B.
Clark, F. H.	Holdrege, C. B.	Rowley, S. T.
Cooke, W. J.	Hooven, A. E.	Royal, Geo.
Coke, W. J.	Humphrey, A. L.	Sanborn, J. G.
Cooke, Allen	Hunt, Thos. B.	Schlegell, F. von
Corbett, W. H.	Jennings, D. F.	Schroyer, C. A.
Cota, A. J.	Johann, Jacob.	Sherman, L. B.
Crandall, B.	Jones, Morgan T.	Stark, F. H.
Cross, C. W.	Keeler, Sanford.	Stimson, O. M.
Cushing, G. W.	Kirby, T. B.	Stocks, W. H.
Deming, H. V.	Kuhlman, Henry	Sullivan, C. L.
Downer, E. N.	LaRue, H.	Sullivan, E. B.
Dunham, W. E.	Lewis, B. T.	Sweney, Don
Duntley, W. E.	Linn, H. R.	Symington, E. H.

Thompson, E. B.	Talmage, J. T.	Wickersham, R. S.
Taylor, J. N.	Tratman, E. E. R.	Woods, E. L.
Thurnauer, G.	Walbank, R. T.	Younglove, J. C.
Towsley, C. A.	Webster, H. D.	

THE CHAIRMAN: The first order of business will be the approval of the minutes as printed. If there are no objections, they will stand approved. The secretary's report is the next business.

The secretary then read the following report:

Membership, March	1,078
New members approved by the Board of Directors....	7
Total membership	1,085

New members:

NAME.	OCCUPATION AND ADDRESS.	PROPOSED
R. B. Kadish,	Akron Mining, Milling & Mfg. Co., Chicago	D. F. Jennings.
W. H. Libkernan,	Standard Steel Car Co., Chicago	A. E. Hoover.
S. B. McMichael,	American Loco. Equipment Co., Chicago	F. von Shlegell.
H. C. May,	M. M. C., C., C. & St. L. Ry., Louisville, Ky.	T. A. Lawes.
F. C. Carriel,	University of Illinois, Champaign, Ill.	L. P. Breckenridge.
W. B. Hall,	Mather Stock Car Co., Chicago	G. T. Anderson.
J. J. Cummings,	Prest. McGuire-Cummings Mfg. Co.	W. J. Cook.

THE CHAIRMAN: The next will be the report of the Committee on Revision of the Rules of Interchange, Mr. Schroyer, chairman. It is as follows:

REPORT OF COMMITTEE ON REVISION OF THE RULES OF INTERCHANGE.

To the members of the Western Railway Club.

Your Committee to advise what revision is necessary in the Rules of Interchange asked for suggestions from the members, and has given the same consideration.

The Committee believes that the rules, as at present revised, are working pretty satisfactorily, and therefore has given its approval to but few of the suggestions offered. The changes suggested refer to the rules of 1903, to which reference should be made. Where no mention of rule number is made, the Committee has no suggestion to offer.

The Committee would suggest that at the meeting of the Club, the rules be called off number by number, and the suggestions of the Committee as well as any additional suggestions by the members, be discussed.

RULE 2, PAGE 2:

The Committee recommends the insertion of a paragraph reading as follows:

Loaded cars must be accepted; if not in serviceable condition to suit the requirements of the receiving road, the receiving road to transfer the freight at its own expense.

RULE 3, PAGE 3:

The Committee would call attention to the importance of that portion of Rule 3 which requires that defect cards should be printed in red ink on both sides to distinguish them from other cards on the cars. It is found that in many cases this is not being done.

RULE 10, PAGE 4:

The Committee suggests that this rule should be changed to read as follows:

Worn flange: Wheels under cars of *less than* 80,000 pounds capacity with flanges having flat vertical surfaces extending more than one inch from tread, or flange one inch thick or less. Wheels under cars of 80,000 pounds capacity *or over* with flanges having flat vertical surfaces extending more than ⅞ inch from tread, or flange 1 1-16 *or less* in thickness.

RULE 19, PAGE 5:

The question of reducing the length of the flat spot under cars of 80,000 pounds capacity or over from 2½ inches to 2 inches was discussed, but no recommendations have been made by the Committee. The question is left for the meeting to decide whether any lower limits should be made for these cars.

RULE 21, PAGE 8:

In accordance with the suggestions regarding Rule 10, the notes under Figures 4 and 4a should be changed to read as follows:

Figure 4.—For wheels under cars of *less than* 80,000 pounds capacity, with flanges one inch thick or less; 80,000 pounds capacity *or over* with flanges 1 1-16 inches or less in thickness.

Figure 4a.—For wheels under cars under 80,000 pounds capacity, 1 inch from tread; 80,000 pounds capacity or over ⅞ inch from tread.

RULE 23, PAGE 12:

The Committee recommends that the last paragraph of this rule be changed to read:

All cars to have their *light weight* and capacity stenciled on them.

RULE 30, PAGE 13:

The question of stenciling both sides of the cylinder to show the date of last cleaning was considered by the Committee, but it was not thought advisable to make any recommendations.

The Committee would also call attention to the fact that many roads are marking the date of the last cleaning and oiling of the cylinders with chalk instead of white paint. This is bad practice and should not be continued.

RULE 32, PAGE 13:

The Committee believes that torn air brake hose should be an operating company's responsibility and this rule should be changed accordingly.

RULE 34, PAGE 13:

The Committee recommends that the last ten words, "unless the car is stenciled that it is so equipped," be eliminated, as it is of the opinion that the owners of cars so equipped should maintain the hose and pipe.

RULE 35, PAGE 14:

The Committee recommends that the rule be changed to read:

Locks, side doors, *end doors and side and end door shields*, grain doors, and all inside or concealed parts of cars missing or damaged under fair usage, etc., etc.

RULE 39, PAGE 14:

The Committee recommends that the rule be changed to read as follows:

Material missing from body of cars, offered in interchange, except locks, side doors, *end doors and side and end door shields*, grain doors and all missing or concealed parts of car.

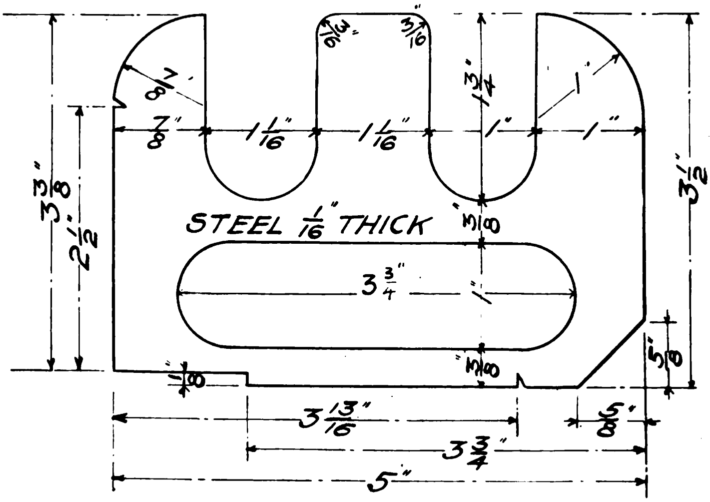
RULE 54a:

It has been found that the wheel defect gauge shown on page 6 can be modified without in any way interfering with its usefulness as a wheel defect gauge, so that it can be made available for gauging worn couplers to determine if they are safe for service. The distance between the pulling face of the knuckle and the body of the coupler, 3 13-16 inches, and the distance between the guard arm and the knuckle, 5 inches, are the principal measurements.

The wheel defect gauge as now adopted is 4⅞ inches long. By adding ⅛ inch to the middle section of the gauge, making it 1 1-16 inches instead of 15-16 inch, the required gauge for the distance between the guard arm and knuckle is obtained.

To show the distance between pulling face of the knuckle and body of coupler, 3 13-16 inches, a small notch is cut on the bottom edge similar to the one on side edge for gauging flat spots.

A drawing is given herewith showing the gauge as modified. The Committee would recommend the use of such a gauge.



RULE 59, PAGE 17:

Your Committee would recommend the elimination of this rule, as there is no longer any occasion for applying couplers other than the M. C. B. type.

RULE 64, PAGE 19:

The Committee would recommend that the last paragraph of this rule fixing a limitation on age of wheels applied be omitted.

RULE 73, PAGE 20:

The Committee recommends the omission in the first and second lines of the words "two or more cars chained together, or any cars," so that the rule will read: "When cars which require switch chains to handle them are delivered at an interchange point," etc., etc.

RULE 95, PAGE 34:

The Committee would suggest that the word "current" be inserted before the word "market" in the second line, so that the rule will read: "In the application of channels they should be charged out at the *current* market price, plus the necessary labor for drilling," etc., etc.

RULE 99, PAGE 35:

The Committee would recommend an additional paragraph reading as follows:

Lost brake shoes may be renewed at owner's expense without the necessity of procuring defect card.

RULE 102. PAGE 35:

The Committee would recommend that this rule be changed to read:

No percentage to be added to either labor or material *except when the owners of cars are not subscribers to the rules of interchange.*

RULE 105. PAGE 41:

The Committee recommends the omission of the words "brake shoes or brake shoe keys" in the next to the last line.

RULE 115, PAGE 51:

The Committee suggests that the item of "loose wheels" be added after the word "construction" in the fourth line.

C. A. SCHROYER,
Chairman.
JOS. BUKER,
H. LA RUE,
C. DEEN,
C. M. MILEHAM,
Committee.

THE CHAIRMAN: The secretary will call off the rules by number, and the suggested change in the report of the committee will be acted upon as each rule is reached.

The secretary called off the rule numbers during which the following suggested changes were acted upon:

THE SECRETARY: Rule 2.

MR. SCHROYER: Mr. President, it is suggested that Rule 2 be revised to read as follows: "Loaded cars must be accepted; if not in serviceable condition to suit the requirements of the receiving road, the receiving road to transfer the freight at its own expense." This is to be inserted in this rule.

It was moved and seconded that the amendment be adopted.

THE CHAIRMAN: It is moved and seconded that the recommendation of the committee be adopted. Are there any remarks?

MR. F. H. STARK (Pittsburg Coal Co.): Mr. President this subject I believe comes up every year with the Western Railway Club. I understand that the interests here in Chicago make it necessary to have a local agreement to this effect, but to make it general, I doubt very much whether it is the right thing. I have had a good many years' experience along the Ohio river, where there is a great deal of timber loaded in the South and is brought up to what we term the Northern roads, in very bad shape, and if this rule were to go into effect it would encourage the careless loading of all kinds of product, and would involve an expense on the receiving road covering the carelessness of the delivering road. For instance, you take ship timber, or any of the long timber from the south, as I understand it, in this case the receiving

road would have to bear the expense of reloading that car or transferring it. As to whether this rule would cover overloads, I don't know whether the committee intended that the receiving road would have to pay for transferring overloads or not.

MR. SCHROYER: Mr. President, I think the gentleman is out of order. It is not a question of loads, it is a question of condition of car.

THE CHAIRMAN: It is, as I understand it, the condition of the car.

MR. STARK: I beg your pardon, sir.

THE CHAIRMAN: Any further remarks? If not, we will vote.

The question being put, the recommendation of the committee was adopted.

THE SECRETARY: Rule 3.

MR. SCHROYER: The committee would call attention to the importance of that portion of Rule 3 which requires that defect cards should be printed in red ink on both sides to distinguish them from other cards on the cars. It is found that in many cases this is not being done. And while there is not anything that can be added to the rules, to enforce the requirement of having these M. C. B. cards printed in red ink, the committee wants to call the attention of the meeting to the fact that it is not done in a great many cases, and the result is that it leads to confusion among the men who have to handle these cars, because ordinarily you can tell at a glance what a card is for by the shape of the card and the color of the ink it is printed with. We want to emphasize that; call the attention of the association to that fact.

THE SECRETARY: Rule 10.

MR. SCHROYER: The committee suggest that this rule should be changed to read as follows:

"Worn flanges: Wheels under cars of less than 80,000 pounds capacity, with flanges having flat vertical surfaces extending more than one inch from tread, or flange one inch thick or less. Wheels under cars of 80,000 pounds capacity or over with flanges having flat vertical surfaces extending more than seven-eighths inch from tread, or flange 1 1-16 inches or less in thickness."

The change in that rule, as you will observe, has been made to include cars of 80,000 pounds capacity and over in the thicker flange, and the less height of the vertical surfaces. Heretofore the rule has required that cars of 80,000 pounds and less could run with a flange one inch vertical surface and one inch in thickness. Now, we think that the 80,000-pound car should be included in the higher carrying capacity cars in so far as the condition of wheels is concerned. I believe it is found generally among the roads that are handling 80,000-pound cars that they are having more or less trouble with the wheels, and for that reason the committee thinks it advisable to have that change made.

THE CHAIRMAN: What action shall be taken?

It was moved and seconded that the recommendation of the committee be adopted. Carried.

MR. SCHROYER: The question of reducing the length of the flat spot under cars of 80,000 pounds capacity or over from 2½ inches to 2 inches, was discussed, but no recommendations have been made by the committee. The question is left for the meeting to decide whether any lower limits should be made for these cars.

Now this point is in your hands to determine, as to whether you want to have wheels removed under these high carrying-capacity cars with spots less than 2½ inches in length.

THE CHAIRMAN: What is your pleasure, gentlemen? This question is before you for discussion.

MR. STARK: Mr. Chairman, this subject came up not long ago, and the question was asked whether there was a prevalence of cracked wheels on account of slid flat wheels, and the members seemed to be of the opinion that there was no increase in the number of wheel failures on account of flat wheels, therefore there seemed to be no nceessity for cutting the wheels out closer, and I believe until such time as we have some evidence, that we are taking too great a chance, we would better leave the rule as it now stands, and if it be in order I will move that that particular rule remain as it is.

MR. SCHROYER: That is not necessary.

THE CHAIRMAN: It is not made as a recommendation, Mr. Stark, our attention is simply called to it. If there is no further discussion, we will pass to the next rule.

THE SECRETARY: Rule 21.

MR. SCHROYER: It is thought as regards Rule 21 that the phrase ology under figure 4 should be changed to read as follows:

"For wheels under cars of less than 80,000 pounds capacity, with flanges one inch thick or less; 80,000 pounds capacity or over with flanges 1 1-16 inches or less in thickness."

That is to conform with Rule 10; the changing of Rule 10 makes it necessary to change the requirements of Fig. 4 and Fig. 4a.

Fig. 4a: "For wheels under cars under 80,000 pounds capacity, one inch from thread; 80,000 pounds capacity or over, ⅞ inch from thread.

THE CHAIRMAN: What is your pleasure, gentlemen?

On motion, the recommendation of the committee was adopted.

THE SECRETARY: Rule 23.

MR. SCHROYER: Rule 23. The committee recommend that the last paragraph of this rule be changed to read:

"All cars to have their light weight and capacity stenciled on them."

You will observe that the rule as it now reads is "All cars to have their capacity stenciled on them." This is to include light weight as well as capacity.

On motion, the recommendation of the committee was adopted.

THE SECRETARY: Rule 30.

MR. SCHROYER: The question of stenciling both sides of the cylinder to show the date of last cleaning was considered by the committee, but it was not thought advisable to make any recommendations.

The committee would also call attention to the fact that many roads are marking the date of the last cleaning and oiling of the cylinders with chalk instead of white paint. This is bad practice and should not be continued.

By some members of the committee it was thought advisable to stencil the date of the last cleaning on both sides of the cylinders, which would enable inspectors to see it from either side of the car. In many places inspection is done by one man, and he can only tell from the side of the car nearest which the cylinder is located when the cleaning was last done, and the inspectors on our line consider that it will be a great advantage to have those cylinders marked on both sides. Although we make no recommendations, we leave that for the members to express their wish.

THE CHAIRMAN: What is your pleasure, gentlemen? Any remarks on this question? If not, we will go ahead.

THE SECRETARY: Rule 32.

MR. SCHROYER: The committee believes that torn air brake hose should be an operating company's responsibility, and this rule should be changed accordingly.

The rule as it now reads is that the delivering company is responsible for "Missing or torn air brake hose or missing or torn air brake fittings, angle cocks, cutout cocks, cylinders and reservoirs, triple valves, release valves and pressure-retaining valves or parts of any of these items."

THE CHAIRMAN: What is your pleasure, gentlemen?

MR. W. E. SHARP (Armour Car Lines): What does the committee mean by the operating company's responsibility?

MR. PECK (Chicago & Western Indiana R. R.): Mr. Chairman, I am not in favor of the recommendation of the committee for this reason: It makes the operating company responsible for the hose while the car is in its possession. Cars frequently leave home and are gone some three or four months and are all the time earning money for their owner, and during that time a hose might fail under fair usage, and the owner should be responsible. At a meeting of the committee a question was brought up and it was claimed that the train men did not uncouple the hose, and we all know this is the practice, and the committee argued that if the hose was torn in uncoupling it was owner's defect, and if it tore so it was weak enough to be removed, it was removed and owner billed, and since that time this has been the practice, but if the car is offered in interchange with torn hose, the company so offering it will have to furnish M. C. B. card.

MR. STARK: Mr. Chairman, if I remember right, when Mr. Herr read a paper before this club on the Air Brake, he said that it was his opinion that while they intended to make a hose coupling that was automatic, that he considered it bad practice to separate cars without disconnectig the air hose, and if the Westinghouse people themselves

will not admit that the hose couplings are automatic in a practical way, and if we admit that it is bad practice to separate cars without disconnecting the hose, why should the owner be responsible for a bad practice? We all know that in the winter time when the couplings are filled with snow and ice, frozen, that unless the hose couplings are disconnected they are liable to tear the hose, and if it breaks off the train line, why, it is evident that there is something there that offers a resistance, and I believe that the road operating the car—the delivering road—should be responsible in every case for torn air hose.

MR. PECK: Mr. President, the delivering road is responsible now, but regarding the operating road—as I understand from Mr. Schroyer, it does not matter who has the car in possession, whether it is delivered, or whether they have it in possession they pay for the hose instead of the owner paying for it.

THE CHAIRMAN: Any further remarks?

MR. O. M. STIMSON (Swift Refr. Car Line): Mr. Chairman, I don't think the question is made clear as to what interpretation can be put upon the "operating company." I don't think Mr. Peck has answered Mr. Sharp's question as to what is meant by an "operating company." If it is not either the owner or the delivering company, I think there would be an opportunity for misunderstanding it.

THE CHAIRMAN: Any further remarks? If not, we will vote on this question.

The recommendation of the committee was defeated.

THE SECRETARY: Rule 34.

MR. SCHROYER: The committee recommends that the last ten words, "unless the car is stenciled that it is so equipped," be eliminated, as it is of the opinion that the owners of cars so equipped should maintain the hose and pipe. This is Rule 34:

"If the car has air-signal pipes or air-brake pipes, but no air brakes, the hose and couplings on the car are at owner's risk, unless the car is stenciled that it is so equipped."

Now, the committee is of the opinion that the owners of the car should be responsible for the maintenance of the pipes and hose under all conditions, and they make that recommendation.

It was moved and seconded that the recommendation be adopted.

THE CHAIRMAN: Are there any remarks?

MR. E. W. PRATT (C. & N. W. Ry.): I rise for information. Do the words contemplate the stenciling on this car?

MR. SCHROYER: No matter whether it is or is not.

MR. PRATT: How would the receiver know when to ask for a card?

MR. SCHROYER: If the pipes and the hose and the whole thing is missing, and there is no evidence about the car to show that they were on the car, they would not ask for a card—no more than you could ask for an air brake if the whole thing was missing and there is no evidence on the car to show that it was ever on.

THE CHAIRMAN: Any further remarks? If not, we will proceed to vote.

The question being put, the recommendation of the committee was adopted.

THE SECRETARY: Rule 35.

MR. SCHROYER: The committee recommends that the rule be changed to read: "Locks, side doors, end doors and side and end door shields, grain doors, and all inside or concealed parts of cars missing or damaged under fair usage," etc.

The addition to that rule is the following: That it is to embrace end doors and side and end door shields. We have fully as much trouble with those shields and with the end doors as we do with the side doors today, and then any defects in those parts or any losses to those parts are at the owner's risk. Defects to those parts, unless due to wreck, are easily determined, and the shields on the side doors and end doors are either nailed or screwed; there is none of them that are bolted, and by the jarring of the car in service, those shields come off, and the owners of the car should be responsible for them.

On motion, the recommendation of the committee was adopted.

THE SECRETARY: Rule 39.

MR. SCHROYER: Rule 39 is made to harmonize with Rule 35. The committee recommend that the rule be changed to read as follows: "Material missing from body of cars, offered in interchange, except locks, side doors, end doors and side and end door shields, grain doors and all missing or concealed parts of car."

On motion the recommendation of the committee was adopted.

THE SECRETARY: Rule 54a.

MR. SCHROYER: It is known by all car men that most car builders have an M. C. B. coupler and defect gauge, which is somewhat complicated in construction and takes skill to operate it. It has been found that the wheel defect gauge shown on page 6 can be modified without in any way interfering with its usefulness as a wheel defect gauge. So that it can be made available for gauging worn couplers to determine if they are safe for service. The distance between the pulling face of the knuckle and the body of the coupler, 3 13-16 inches, and the distance between the guard arm and the knuckle, 5 inches, are the principal measurements.

The wheel defect gauge as now adopted is 4⅞ inches long. By adding ⅛ inch to the middle section of the gauge making it 1 1-16 inches instead of 15-16 inch, the required gauge for the distance between the guard arm and knuckle is obtained. Instead of having it 15-16 inch, make it 1 1-16 inches, and you have a guage that will meet both requirements. It is light in weight and the inspectors all carry it around in their pockets, and they can measure defects on the couplings with that just as well as they can defects on the wheels. By adding ⅛ inch to the middle section of the gauge, making it 1 1-16 inches

instead of 15-16 inch, the distance between the guard arm and the knuckle is obtained, and we think that that is a very important thing. The defect coupler gauge that they use today I think costs something like $18 or $19, and here is that little piece of sheet iron stamped out in that shape to make it an eighth of an inch longer meets all the requirements of that $18 gauge.

On motion, the recommendation of the committee was adopted.

THE SECRETARY: Rule 59.

MR. SCHROYER: Rule 59. "Couplers of the vertical plane type other than M. C. B. replaced with M. C. B. standard, the expense of alteration thus necessitated, shall be chargeable to car owners."

The committee considers that this rule is of no further use to the association, and recommends its elimination entirely from the rules, as there is no other style of vertical coupler used today except the M. C. B.

Moved and seconded that the recommendation of the committee be adopted.

THE CHAIRMAN: Are there any remarks?

MR. STARK: Mr. Chairman, I would like to ask how this would apply to roads using the vertical plane type coupler but making a coupler an inch difference in length. Then there is still another road that has a coupler designed with the coupler shank narrower at the back end in order to have it pass in between the draft attachments. Under the present rules, if one of those couplers break, the road handling the car can change the attachments, making the M. C. B. standard coupler shank applicable. If we eliminate this, and we get hold of one of those cars that have a specially designed coupler shank, how are we going to make the change unless we do it at our own expense?

There is still another road that makes a different butt end to the coupler shank and uses a single rivet instead of two rivets. Of course that would not cut any figure in this particular case, but it would where the coupler was longer or where the draft attachments are so close that you can't get the M. C. B. type in.

MR. SCHROYER: Mr. Chairman, this rule refers to couplers other than the M. C. B. type. The type of the M. C. B. coupler is the contour lines of the coupler, the vertical plane coupler. Now, anything that is on the M. C. B. lines is the M. C. B. type in fact, and it has reference to other couplers than that. If you will recall the fact, during the time the M. C. B. coupler was being generaly introduced, there were a number of other couplers that came into use, and some roads were opposed to the M. C. B. coupler, but that has all disappeared, so that the necessity for this rule no longer exists. I believe that the M. C. B. requirements in a coupler are all that is desired under conditions existing to-day. I don't believe that anybody is justified in putting in anything else than an M. C. B. coupler to-day, and if you do, and it is necessary that that

coupler be changed while on our road, it should be done at your expense, if it is done in accordance with the M. C. B. rules.

The question being put, the motion was carried.

THE SECRETARY: Rule 64.

MR. SCHROYER: "Wheels on the same axle must be of the same circumference."

"No wheels to be applied to foreign cars that the dates cast show them to be over six years old."

The committee recommends that the last paragraph of this rule, fixing a limitation of age of the wheels, be omitted. We feel that it is working a hardship to-day in the handling of wheels in our repair yards; that it is costing us very much more money than we ever lost by any of the wheels that have been used on our cars under the old rule, and for that reason we would recommend the elimination of this last clause of the rule.

Moved and seconded that the recommendation of the committee be adopted. Carried.

THE SECRETARY: Rule 73.

MR. SCHROYER: Rule 73 refers to the switch chains on cars in handling them. The committee recommends the omission in the first and second lines of the words "two or more cars chained together, or any cars," so that the rule will read:

"When cars which require switch chains to handle them are delivered at an interchange point, the receiving road shall deliver to the delivering road at the time an equivalent number of switch chains of the same size as the chain so used on the cars delivered, or, in lieu thereof, furnish a defect card for such chains."

The object of this is to cover the delivery of chains that have been applied to defective cars rather than to chains that are applied to two cars that are loaded with the same load. Many roads now are not handling double-loaded cars with switch chains at all, and the rule as it stands to-day works a hardship and is a constant source of bickering and contention among our inspectors, and sometimes it goes beyond the inspectors, in getting back the chains that are on double loads. Now, the committee wants the road delivering cars that are so claimed to remove their own chains before the delivery is made.

On motion, the recommendation of the committee was adopted.

THE SECRETARY: Rule 95.

MR. SCHROYER: The committee would suggest that the word "current" be inserted before the word "market" in the second line, so that the rule will read:

"In the application of channels they should be charged out at the current market price, plus the necessary labor for drilling," etc., etc.

On motion, the recommendation of the committee was adopted.

THE SECRETARY: Rule 99.

MR. SCHROYER: The committee would recommend an additional paragraph, reading as follows:

"That brake shoes may be renewed at owner's expense without the necessity of procuring defect card."

If the brake shoe, as you know to-day, is lost on your own road, you can replace that shoe at the owner's expense, but if that car is delivered in interchange, it requires your inspector to go to the inspector of the delivering road and get an M. C. B. defect card before you can bill on it, and therein is the hardship. It costs more money to-day to hunt up that inspector and get a defect card than is involved in the price of changing the shoe and the value of the shoe. For that reason we make this recommendation.

It was moved and seconded that the recommendation of the committee be adopted.

MR. SHARP: Mr. Chairman, I notice further on in the recommendation that you recommend the striking out of the words "brake shoe." In that case it makes the car owner responsible for both labor and material. I would like to ask why you would make this change?

THE CHAIRMAN: Will you answer that, Mr. Schroyer?

MR. SCHROYER: I did not understand the question.

MR. STARK: Mr. Chairman, I don't know of anything to hinder the receiving road—it might be in a technical sense, but the receiving road can receive a car with missing brake shoes, and I don't know that there is anything to prevent it from making a bill for it, either. I believe the receiving road, if it takes the car and puts it into its own yard and puts a brake shoe on it, I don't know who is going to have any tab on it, or who is going to raise any objection to it. The idea of making the delivering company responsible was to force the delivering company to put the car in a good, safe condition before delivering it, and that applies to the couplers and to the brakes in general. It was to force the delivering company to put the car in a good, serviceable condition. If, however, the receiving road desires to accept a car with missing material and makes the repairs, I think if you are all honest about it, you will all say that you make a bill, and I don't see that anybody is going to raise any objection to it. As it is now, the receiving road can refuse a car with missing material unless it has a defect card if it wants to, but in all the interchange points that I have anything to do with the receiving road receives the car with missing brake shoes and puts the brake shoes on and charges them up to the owner.

MR. SCHROYER: Mr. President, it is true enough the receiving road can receive a car, if it wants to, in any condition that the car may be in, but we know that our inspectors lose a lot of time in procuring M. C. B. defect cards for missing material because of brake shoes missing. Now, when we change a brake shoe that has been worn out, we get the scrap of the worn-out brake shoe for the labor of putting on the new one. In this particular case when we put a new brake shoe on to

a car that is delivered to us, and one is missing, we get no compensation for the labor of applying the shoe, but the labor of applying the shoe represents so much less than the labor of hunting up a defect card for the missing material that we should think everybody would be willing to have that point covered, and avoid the necessity of inspectors hunting for defect cards. It is only a question of making the thing clear to the inspectors and enabling us to do the work at once. We are doing it now if we want to, but generally they don't want to, because you all know that our inspectors stand on all the technicalities that they can under the rules. The object of this is to make it clear that the inspector does not have to get a card to put on the brake shoe.

THE CHAIRMAN: Any further remarks?

MR. SHARP: Mr. Chairman, my object in asking that question was simply this: it is generally assumed that a missing brake shoe, as covered by the rules, is either missing on account of being broken or on account of key working out of place. There are other conditions, however, that would work a hardship on the car owner if the rule is adopted as recommended by this committee. We can cite numerous cases around the switching yards where cars are placed on a loading track or on a side track and while there they have been robbed of all the brake shoes by the junk men. Now, if this rule is adopted, the company having these cars in their possession will not have to give them the attention that they now give by their police department.

MR. SCHROYER: Mr. Sharp's remarks refer especially to private line cars.

MR. SHARP: Not exactly.

MR. SCHROYER: But the percentage of private line cars to-day is so small that in the adoption of rules governing interchange of cars it should not cut very much of a figure.

THE CHAIRMAN: Is there any further discussion?

The question being put, the recommendation of the committee was adopted.

THE SECRETARY: Rule 102.

MR. SCHROYER: The committee would recommend that this rule be changed to read:

"No percentage to be added to either labor or material except when the owners of cars are not subscribers to the Rules of Interchange."

On motion, the recommendation of the committee was adopted.

THE SECRETARY: Rule 104.

MR. H. LA RUE (C., R. I. & P. Ry.): Mr. Chairman, I would like to call attention to the rule on page 36, the charge for repairing arch bars, two hours, and on page 39, the charge for replacing siding. I think that that price should be increased.

MR. SCHROYER: Let me say that Mr. La Rue did not remain at the meeting long enough—the committee did not go into the question of changing the prices, as there is a Master Car Builders' committee for

that purpose, and for that reason we did not interfere with that at all.

MR. PECK: Mr. Chairman, I think this Club should recommend to the Arbitration Committee any prices they see fit to change. We have not prices enough. Everything should be priced. You charge 20 cents for a brake rod and it is sent back to be changed to 10 cents, and similar things are being done all the time. We ought to have a price on every piece of material we have, as far as we can. Every part of our coupler should have a price named. There are a great many bills returned for the inside parts of couplers—the prices are not right. We should have prices for the inside parts of couplers the same as we do for the drawbar itself.

THE CHAIRMAN: Mr. La Rue, would you offer those suggestions as a motion?

MR. LA RUE: I merely offer that as a suggestion.

MR. PECK: Mr. President, I would suggest if Mr. La Rue has any prices he wishes to bring before the Club, that he bring them in the shape of a motion, so that they can be recommended to the Arbitration Committee. I think it perfectly right that we should have all the information we can get.

MR. LA RUE: I offer as a motion that the charge for blacksmith shop labor for repairing arch bars be two hours for each bar instead of two hours for both bars in case it is necessary, and that the price of siding should be changed from six cents per foot to ten cents.

Motion carried.

THE SECRETARY: Rule 105.

MR. SCHROYER: The committee recommends the omission of the words "brake shoes" or "brake shoes keys" in the next to the last line. The rule as it now reads is:

"No charge to be made for labor of replacing or applying M. C. B. knuckles, knuckle pins, locking pins, clevises, clevis pins, lift chains, brake shoes or brake shoe keys, except on the authority of a defect card."

This is in harmony with the action taken as regards the missing brake shoes.

Moved that the recommendation of the committee be adopted.

THE CHAIRMAN: Is the motion seconded?

A MEMBER: Wouldn't it be well for the committee to recommend how much labor should be charged for?

MR. SCHROYER: No labor at all, no charge for the labor of replacing, except on the authority of the M. C. B. defect cards. Read the rule and you will see.

Motion, after being seconded, was carried.

THE SECRETARY: Rule 115.

MR. SCHROYER: You will observe that this rule covers the work which may be done on cars by switching roads. The committee recom-

mends that the words "loose wheels" be added to this rule after the word "construction" in the fourth line, making the rule read:

"Switching roads will only be allowed to render bills against car owners for the following defects repaired by them: Roof lost on account of decay or faulty construction." Then we would have the words "loose wheels, worn-out brasses, broken truck springs," etc., etc.

On motion, the recommendation of the committee was adopted.

THE SECRETARY: Mr. Chairman, those are all the recommendations the committee has to make. If any of the other members have any recommendations to make for the rule following rule 115, we would be glad to hear them.

THE CHAIRMAN: The report as revised should be sent to the Arbitration Committee, and a motion that the report, as revised, be accepted, will be in order.

MR. PECK: I move the report of the committee, as revised, be accepted and referred to the Arbitration Committee as the recommendations of the Club, and that the committee be discharged with a vote of thanks.

Carried.

The suggestions as adopted by the Club are as follows:

RECOMMENDATIONS OF WESTERN RAILWAY CLUB ON REVISION OF THE RULES OF INTERCHANGE.

RULE 2, PAGE 2:

The Club recommends the insertion of a paragraph reading as follows:

Loaded cars must be accepted; if not in serviceable condition to suit the requirements of the receiving road, the receiving road to transfer the freight at its own expense.

RULE 10, PAGE 4:

The Club suggests that this rule should be changed to read as follows:

Worn flange: Wheels under cars of *less than* 80,000 pounds capacity with flanges having flat vertical surfaces extending more than one inch from tread, or flange one inch thick or less. Wheels under cars of 80,000 pounds capacity *or over* with flanges having flat vertical surfaces extending more than ⅞ inch from tread, or flange 1 1-16 *or less* in thickness.

RULE 21, PAGE 8:

In accordance with the suggestions regarding Rule 10, the notes under Figures 4 and 4a should be changed to read as follows:

Figure 4.—For wheels under cars of *less than* 80,000 pounds capacity, with flanges one inch thick or less; 80,000 pounds capacity *or over* with flanges 1 1-16 inches or less in thickness.

Figure 4a.—For wheels under cars under 80,000 pounds capacity, 1 inch from tread; 80,000 pounds capacity or over, ⅞ inch from tread.

RULE 23, PAGE 12:

The Club recommends that the last paragraph of this rule be changed to read:

All cars to have their *light weight* and capacity stenciled on them.

RULE 34, PAGE 13:

The Club recommends that the last ten words, "unless the car is stenciled that it is so equipped," be eliminated, as it is of the opinion that the owners of cars so equipped should maintain the hose and pipe.

RULE 35, PAGE 14:

The Club recommends that the rule be changed to read:

Locks, side doors, *end doors and side and end door shields,* grain doors, and all inside or concealed parts of cars missing or damaged under fair usage, etc., etc.

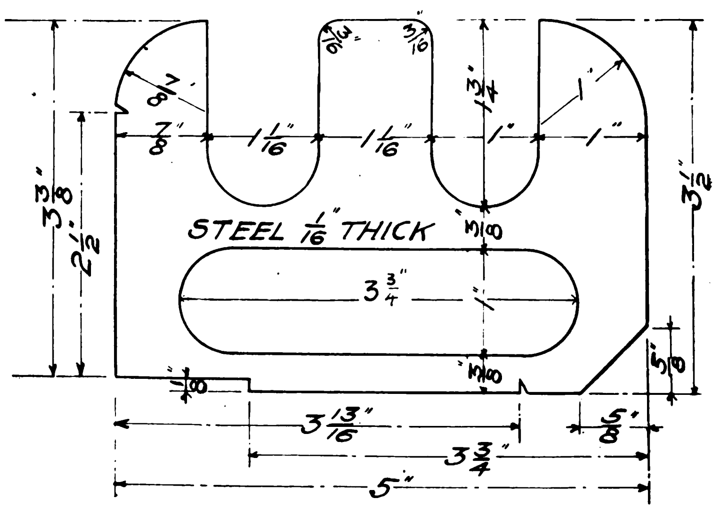
RULE 39, PAGE 14:

The Club recommends that the rule be changed to read as follows:

Material missing from body of cars, offered in interchange, except locks, side doors, *end doors and side and end door shields,* grain doors and all missing or concealed parts of car.

RULE 54a:

It has been found that the wheel defect gauge shown on page 6 can be modified without in any way interfering with its usefulness as a wheel defect gauge, so that it can be made available for gauging worn couplers to determine if they are safe for service. The distance between the pulling face of the knuckle and the body of the coupler, 3 13-16 inches, and the distance between the guard arm and the knuckle, 5 inches, are the principal measurements.



The wheel defect gauge as now adopted is 4⅞ inches long. By adding ⅛ inch to the middle section of the gauge, making it 1 1-16 inches instead of 15-16 inch, the required gauge for the distance between the guard arm and knuckle is obtained.

To show the distance between pulling face of the knuckle and body of coupler, 3 13-16 inches, a small notch is cut on the bottom edge similar to the one on side edge for gauging flat spots.

A drawing is given herewith showing the gauge as modified. The Club would recommend the use of such a gauge.

RULE 59, PAGE 17:

The Club would recommend the elimination of this rule, as there is no longer any occasion for applying couplers other than the M. C. B. type.

RULE 64, PAGE 19:

The Club would recommend that the last paragraph of this rule fixing a limitation on age of wheels applied be omitted.

RULE 73, PAGE 20:

The Club recommends the omission in the first and second lines of the words "two or more cars chained together, or any cars," so that the rule will read: "When cars which require switch chains to handle them are delivered at an interchange point," etc., etc.

RULE 95, PAGE 34:

The Club would suggest that the word "current" be inserted before the word "market" in the second line, so that the rule will read: "In the application of channels they should be charged out at the *current* market price, plus the necessary labor for drilling," etc., etc.

RULE 99, PAGE 35:

The Club would recommend an additional paragraph reading as follows:

Lost brake shoes may be renewed at owner's expense without the necessity of procuring defect card.

RULE 102, PAGE 35:

The Club would recommend that this rule be changed to read:

No percentage to be added to either labor or material *except when the owners of cars are not subscribers to the rules of interchange.*

RULE 104, PAGE 36:

The Club recommends that the charge for repairing arch bars be two hours for each bar instead of two hours for both bars in case it is necessary.

Also that the price of siding should be changed from six cents per foot to ten cents per foot.

RULE 105, PAGE 41:

The Club recommends the omission of the words "brake shoes or brake shoe keys" in the next to the last line.

RULE 115, PAGE 51:

The Club suggests that the item of "loose wheels" be added after the word "construction" in the fourth line.

THE CHAIRMAN: The next subject on our program is Mr. King's talk on the subject of the Steam Turbine, but we find it will be necessary to move the screen in under the gallery a little, and while that is being prepared, we will proceed with Mr. Vaughan's paper on The Value of Heating Surfaces. It is as follows:

THE VALUE OF HEATING SURFACE.

By Mr. H. H. Vaughan, S. R. S., Can. Pac. Ry.

In presenting these remarks to the Western Railway Club I feel that an apology is really due to the members for their incompleteness; but as they are connected with a question which has recently been quite an important one for several of us, they may be of interest even if not affording much real information.

You, no doubt, recollect that the Master Mechanics' Association Committee, of which Mr. G. R. Henderson was chairman, recommended a relation between heating surface and cylinder volume of 200 or 220 to 1. The cylinder volume was inconvenient to calculate and has been very little used, and I very much prefer the excellent measure recommended by Mr. Lawford H. Fry, which I hope to see adopted generally in the future, namely, the tractive power at 85 per cent multiplied by the diameter of drivers. When this is divided by the heating surface, Mr. Fry's factor B. D. is obtained. Now to compare these two ratios if R be ration of heating surface to cylinder volume in cubic feet, P the boiler pressure,

$$\text{then B. D.} = \frac{935\,P}{R}$$

thus values of R of 200 with 160 to 180 pounds boiler pressure compare with values of B. D. of 748 and 840 respectively which are very considerably higher than these for any engines built in the last few years.

Without discussing the factor B. D. further I wish to call attention to one way of looking at it which does not seem to be generally noticed, namely, that it is proportional to the pounds of water that have to be evaporated per square foot of heating surface per hour and in fact if regarded in this way it appears to me more easily discussed.

A number of the later large passenger engines have had very low values of B. D. varying down to 600 or 500 and should accordingly have a large margin of steaming capacity if water is evaporated at the same rate per square foot as on older and smaller engines. I have come to the conclusion that this is not the case and in making this remark I wish it to be clearly understood that I refer to the steaming capacity of the engines and not to their economical performance. Had I been able to devote sufficient time to this subject I would very much have liked to present diagrams illustrating this subject for all the engines

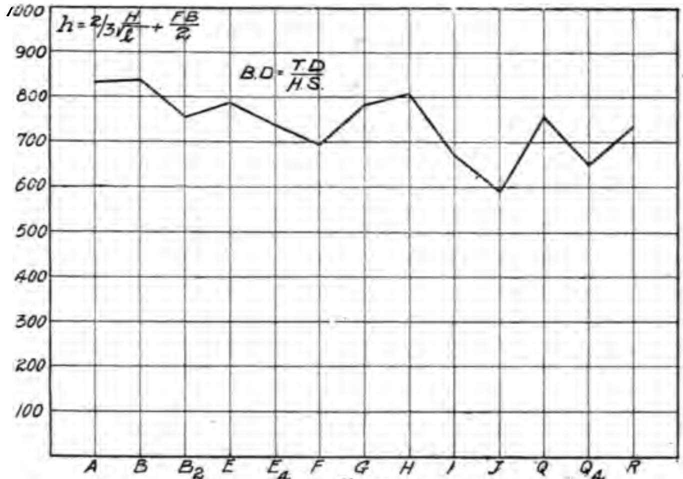


Fig. I.

mentioned in Mr. Fry's paper before the New York Railroad Club as in that case each member could have noticed engines with which he was individually acquainted, but failing that I have restricted the illustration to the engines with whose performance I am best acquainted, those of the Lake Shore and Michigan Southern Railway. Fig. 1 shows the values of B. D. for certain classes of their engines; the values are simply plotted for the classes shown as abscissae in their alphabetical order, a short description of these engines being as follows:

Class	Type	Cylr.	Blr. Press.	Dia. of Drvrs.	Heating Surface Tubes.	F'box.	Total.	Grate Area.	Wgt on Drvrs.	Total Wgt.	Service.
A	2-80	20½x38	180	56	1957	212	2169	32.5	143,500	162,500	Frt.
B	2-8-0	21 x30	200	62	2452	230	2682	33.5	149,000	168,000	Frt.
B2	2-8-0	21 x30	200	62	2786	187	2973	43.0	154,000	174,000	Frt.
2	4-6-0	17 x24	180	68	1440	139	1579	27.0	90,000	115,000	Pass.
24	4-6-0	17 x24	160	56	1146	126	1272	22.0	80,000	105,000	Frt.
F.	4-6-0	18 x24	190	68	1665	150	1815	27.0	88,000	118,000	Pass.
G	4-6-0	18 x26	190	68	1550	179	1729	24.0	110,000	140,000	Pass.
H	4-6-0	19½x30	180	62	1957	202	2159	32.5	118,000	158,000	Frt.
1	4-6-0	20 x28	200	80	2660	202	2862	33.5	133,000	171,600	Pass.
1	2-6-2	20½x28	200	80	3172	190	3362	48.6	130,000	174,500	Pass.
Q	4-4-0	17 x24	180	72	1234	155	1389	18.0	65,000	104,000	Pass.
Q4	4-4-0	17 x24	135	62	1073	142	1215	15.1	48,000	74,000	Frt.
R	4-4-0	18 x24	180	68	1425	154	1579	27.3	71,000	107,000	Pass.

The A is a successful class of narrow firebox, consolidation engine; has always been a good steamer. The B and B2 are Mr. Marshall's consolidations narrow firebox and wide firebox respectively. The E is a highly successful light ten-wheel passenger. It was one of these engines that made the splendid run with Dr. Webb's special some time ago. The E4 have been very satisfactory. The F has also been a highly successful class of engine and ran the 20th Century train during the first summer it was put on, a good performance for an engine of this size.

The G is a solitary engine and has never given satisfaction in passenger service; it has to be used on local or mixed runs. H is a good

class of engine for fast freight and has also been used with good results on heavy passenger runs that are not necessarily fast. I is Mr. Marshall's ten-wheel passenger engine on which he decided the limitation occurred in the grate and "I" is his prairie passenger. Q is a class of eight-wheel engine that was used in the 20-hour trains in the World's Fair year, but which are very delicate steamers. Q4 is a good eight-wheeled freight engine, the class that is seldom heard from; R is an 18-inch passenger eight-wheeler, a fair engine but not remarkably good.

Now, remembering that the ratio B. D. means that the pounds of water evaporated per square foot of heating surface per hour are equal for equal B. D. under equal conditions of revolutions, throttle and cut-off, in other words when engines are being worked up to their relative capacity, I do not hesitate to say that it does not accurately represent the conditions. While the I engines are good steamers they are not on that basis the equal of the E, and I do not consider them quite equal to the F. The Q are certainly not equal to the E or F and neither are the R. The H are, I think, rather better than the B when pressed. While the question may appear rather theoretical it became of some importance in connection with the design of new passenger power in which we wished to feel reasonably certain that the steaming qualities should be good. Several of the later Prairie and Pacific engines have necessarily like the I, a flue of considerably greater length than was common on older power and the question has frequently been raised as to whether the figures for heating surface arrived at by the length of the flue really indicated the steaming capacity, leaving out any reference to their economical effect. It occurred to me that an analysis of the experiments carried on to determine the evaporation from various sections of the flue, might give some indication of the allowance that should be made. I refer to those made by M. Petiet about 1865 and while I have heard these experiments spoken of as being of little value, I do not know the objections that have been raised against them. They appear to have been most carefully carried out and under conditions that are very fairly comparable with those of to-day. An account of them can be found in D. K. Clark's "Steam Engine" and is interesting reading.

Without going into an extended description, a boiler having a grate area of 9 sq. ft., firebox heating surface 60.28, and 125 tubes 1⅞ ins. dia., 12 ft. 4 ins. long, had the tubes divided into four sections each 3.01 ft. long, leaving 3½ ins. of tubes attached to the firebox, forming the 5th section. Test was carried out with coke and with briquettes, the former of which may, I think, be neglected. With briquettes coal was burnt up to 113 lbs. per square foot of grate per hour, which is a fairly high rate of combustion. Tests were also made with one half of the flues stopped off.

On looking over the curves showing the evaporation for various portions of the tubes, they appeared to have a general similarity to a parabola. In that case the evaporation per square foot from a flue of any length would be the same if the square root of the length of the flue

were taken in place of the actual length. Fig. 2 shows the results when plotted on that basis with pounds of coal per square foot of grate per hour as abscissae and water evaporated per square foot of heating surface per hour as ordinates. The top line shows the evaporation from the firebox, the lower ones from the 1st, 2nd, 3rd and 4th sections of

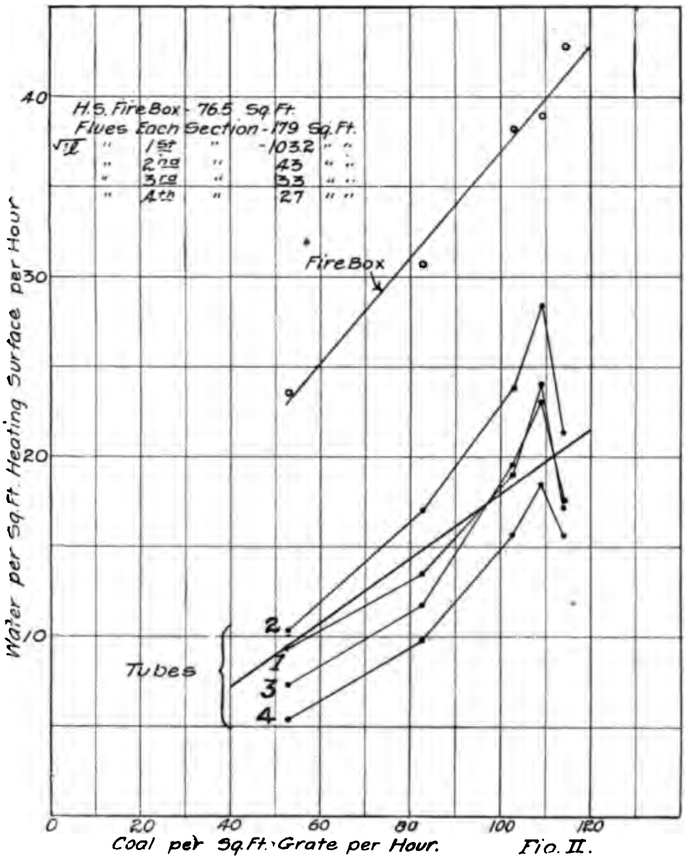


Fig. II.

flues respectively. While on the $\sqrt{l}$ basis the 2nd section does more than the 1st and 3rd and the 4th less, you will see that as the rate of combustion increases the proportional difference becomes less important, in other words, the lines do not radiate. While neither the lines for flues or firebox appear to run through the origin the heavy line amongst the flues is a vector passing through one-half of the evaporation from the firebox at 120 pounds coal per square foot per hour and will be seen to very fairly represent the average result. In this connection I wish to call attention to the remarkable regularity of the results; while there

is evidently something peculiar about the last two tests the flues appearing to do the greater part of the work in one case and the firebox in the other, the results on the whole are excellent and show accurate and careful work. Another point worthy of attention is that there is no indication of any large departure from straight line results in the vicinity of the points plotted. It would thus appear that if the tube heating surfaces be measured by the square root of its length and divided by two, a value is obtained for the equivalent heating surface which may be considered as effective for producing purposes as the firebox heating surface and should be a fairly accurate measure of the boiler capacity. If H be the actual heating surface of the flues, this would be equal to $\frac{H}{2\sqrt{l}}$ when l is the length of the tubes in feet. Another consideration must, however, be taken into account, namely, the amount of heat subtracted by the firebox. There are many experiments that have shown that if the firebox is arranged so as not to take away the heat, more work is done by the flues. It is difficult to say, however, how much this is. In Fig. 3 I assume that with the proportions of the experimental boiler the firebox is unity, and in that case the firebox does 40 per cent of the total work and the flues 60 per cent. With no firebox how much more would the flues do? If there evaporation is measured in the proportion 60 to 80 they will take up half the work that the firebox did. If 60 to 90, three quarters and so on. What ever the flues do with the firebox doing nothing, it is probable will be done proportionally with the firebox varying in size. If this is true, the full lines show the total work done, the dotted lines the work done by the flues. It appeared to me that the line "a" would be the best approximation to adopt and in that case we should require a factor that would make the equivalent of the surface $\frac{2}{3}.\frac{H}{\sqrt{l}}$ with no firebox, as against $\frac{1}{2}.\frac{H}{\sqrt{l}}$ when the firebox surface is $\frac{2}{3}.\frac{H}{2\sqrt{l}}$, that is if F is firebox surface and $A = \frac{H}{\sqrt{l}}$ we wish the equivalent heating surface which may be called h to equal as follows:

$$\text{Where } F = \frac{1}{3}A,\ h = F + \frac{A}{2}$$

$$\text{When } F = O,\ h = \frac{2}{3}A$$

$$\text{Or } h = \frac{2}{3}\frac{H}{\sqrt{l}} + \frac{F}{2}$$

which satisfies these requirements. This all appeared very logical to the writer and Fig. 4 shows the same classes of engines as previously

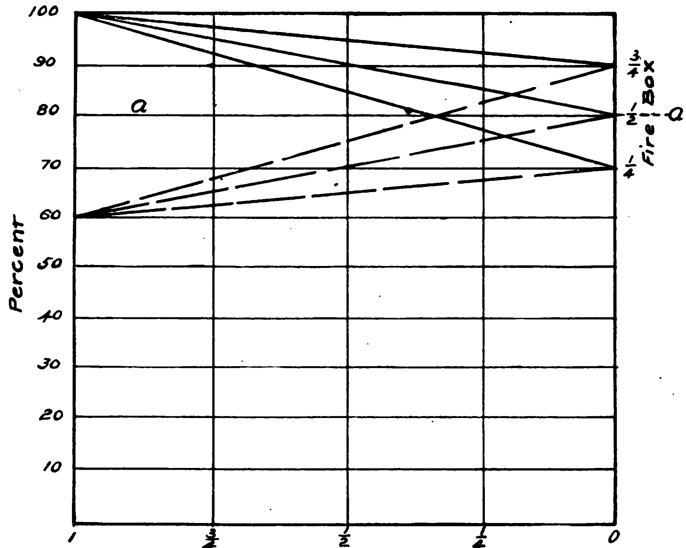


Fig. III.

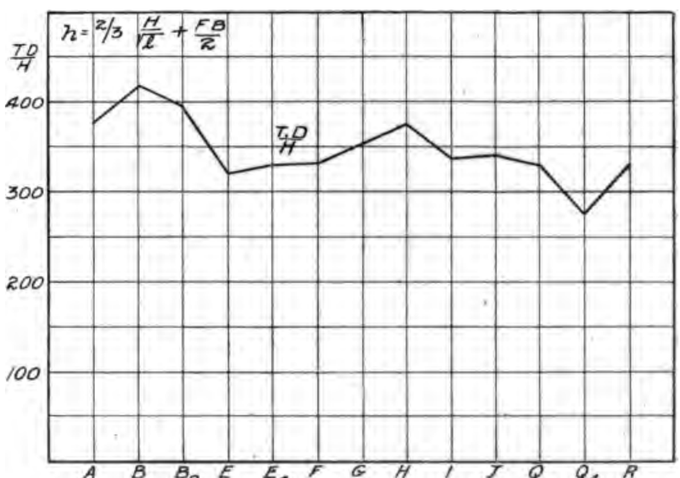


Fig. IV.

plotted taking the equivalent heating surface in place of the actual. This certainly equalizes matters greatly and will be found to do so in the case of any of our large modern engines. It will be seen that the E is one of the best of the engines and that the H are better than the A and B which agrees with our experience. While this method may not be absolutely right, yet I consider that as a measure of effec-

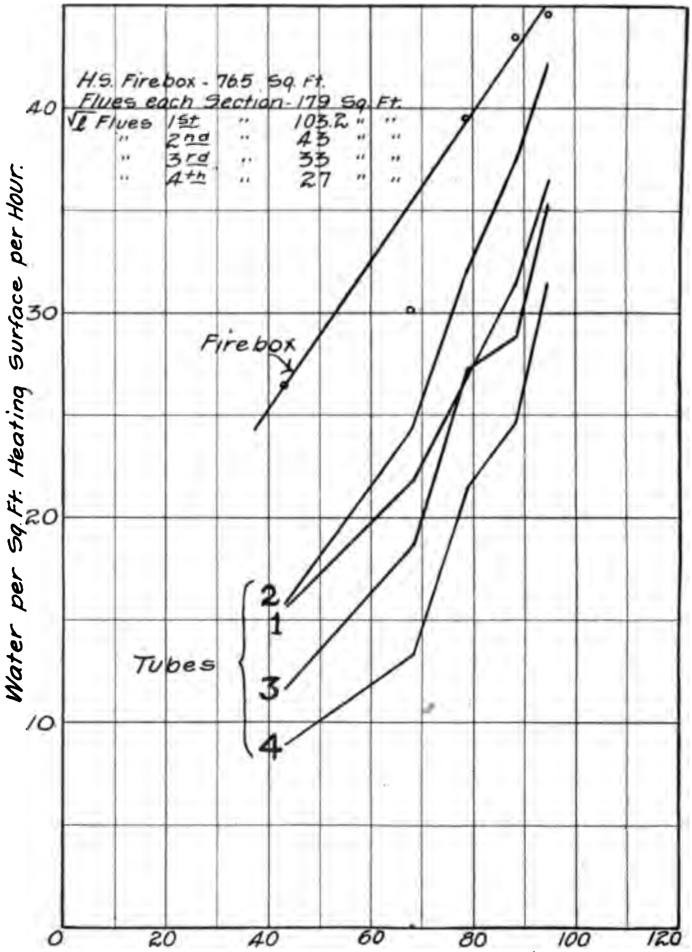


Fig. V

tive heating surface this formula has some little value which must be my cause for explaining at this length its derivation on the hope that if it proves useful some of our members may assist in improving it. I am not satisfied with the method of allowing for the variation in the

effect of the firebox surface but believe that the square root of the length of the flues is the correct way to estimate their value.

After testing this formula I thought it would be interesting to analyze the experiments with half the flues stopped up and Fig. 5 shows information for this series similar to that shown in Fig. 2 for the 1st series. It will be seen that the square root rule holds exceedingly well even when the evaporation per square foot is 75 per cent greater than in Fig. 2. There has been an increase in the evaporation of the firebox which is difficult of explanation but a considerable increase in that from the flues. The question then arose "If in place of plotting with reference to the coal burnt per square foot of grate surface per hour it was plotted with reference to the coal per square foot of heating surface per hour what difference would be shown by the decreased flue surface?" This is shown on Fig. 6, in which the evaporation per square foot of heating surface is plotted with reference to the coal burnt per square foot of heating surface per hour and the results are certainly

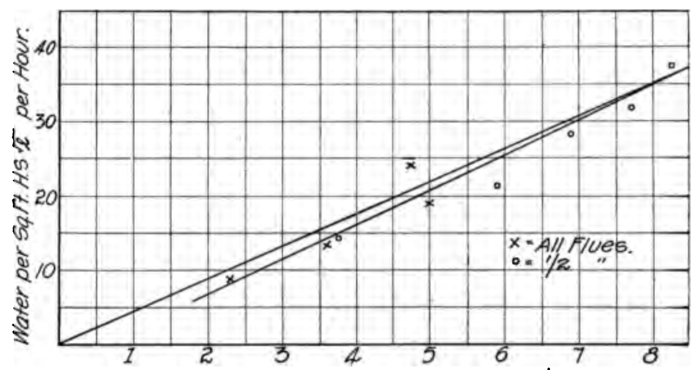


Fig. VI

curious, the "X" represent the tests with all flues, the "O" with half flues and the same line evidently fits both conditions. This would make it appear as if the amount of flue heating surface made no difference so Fig. 7 shows the total water evaporated with reference to the amount of coal burnt per hour. The lower line shows the water evaporated from the flues, the upper that from both flues and firebox. I think that the accuracy of the experiments as indicated by the small variation in the results demands their consideration and it would appear that the heating surface has very little effect in the evaporation, in other words, the reduction in the water evaporated was a draft proposition and not one of heating surface, the obstruction due to the decreased flue area reducing the amount of coal burnt per hour but the decreased heating surface has no effect on the evaporation. It is evident that this statement has its limitations but it is worth seriously considering whether it

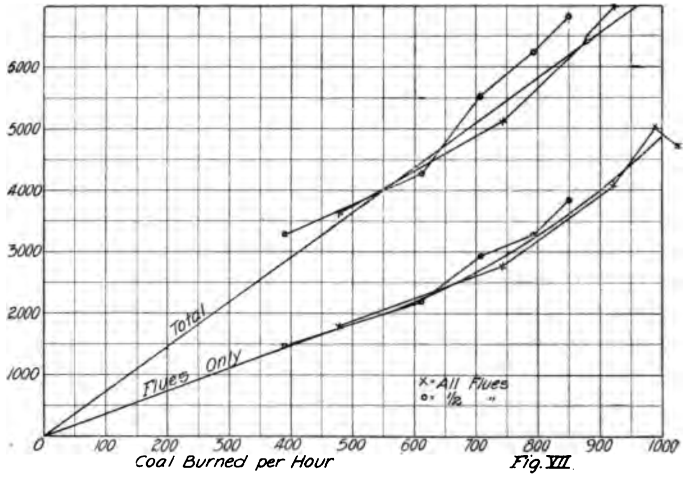


Fig. VII.

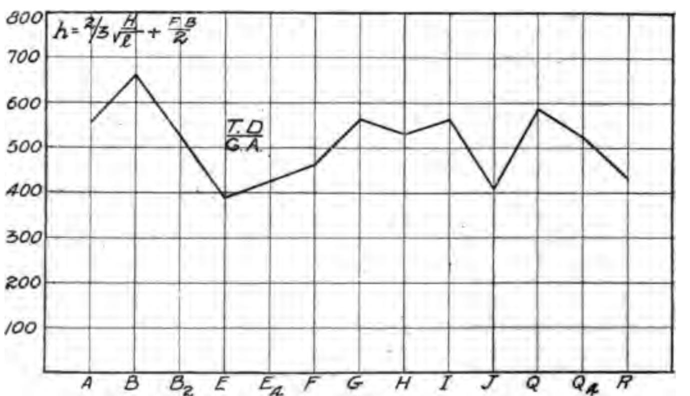


Fig. VIII.

is not practically true. Heating surface can evaporate 40 to 60 lbs. of water per hour and may only be taxed to 4 or 5 so that if it is reduced it simply takes up more and while no doubt its increase leads to economy, within reasonable limits it would have little effect on the capacity. The thing to do is to burn the coal and get the heat and the heating surface will take it up. If this is true the most important ratio in an engine is that of the steam consumption to the grate area, or if T be the tractive force, D the diameter of drivers and A the grate area, the value of $\frac{TD}{A}$. This is plotted for the Lake Shore engines on Fig. 8, and while not the only thing to be considered shows the importance of this relation. This ratio represents the pounds of coal burnt per square foot of grate per hour in the same way as B. D. or as I think it would better be expressed $\frac{T}{H}$. $\frac{D}{S}$ represents the water evaporation. It shows the reason why the E can steam and why the Q is not satisfactory; that the limitation for passenger service should be between 4 and 5 and for freight between 5 and 6. I believe this to be one of the most important ratios in the design of an engine and wish to emphasize its advantage over that of heating surface to grate area which I believe useless and as giving no reliable information, apart from these experiments.

It is not my desire to take the position that heating surface is of little value, certainly not on a solitary series of experiments carried out some years ago, but I have decidedly been led to think whether as a measure capacity the grate area is not the most important factor. It does not follow that it is wise to make the grate too large, a large grate does not necessarily mean coal burnt or burnt well, and it is coal burnt that is wanted. I have noticed on the J engines that if the grate area is used the engines are excellent steamers but that the grate area is frequently not used to burn coal evenly all over; a condition frequent with large engines with 50 or so square feet of grate. The physical limitations of the firemen must be reckoned with; but we should also watch the limitation of the grate and see that it is large enough to burn the coal required of it. In considering this question a number of facts have been explained to me by looking at heating surface in the light of these views, as, for instance, the action of engines in which we have decreased the number of flues, and the good steaming qualities of the P. R. R. class E2 engines which have far less heating surface than other engines of the same type and I have ventured to present these ideas to you in an immature condition, since while they have been more destructive than instructive to my present state of knowledge they are, I think, worth some consideration in our future boiler design.

MR. H. H. VAUGHAN (C. P. Ry.): Gentlemen, I haven't very much to say in excuse of this paper, except that it refers to investigations that we went into in connection with the design of some passenger engines on which, while the boiler they were to have was exceedingly powerful, we wish to be as positive as possible that the cylinders were not too large to allow the engine to be a free steaming engine. The only way in which we are at present able to determine this is by making comparisons between the ratios of the boiler capacity and the steam consumption on existing engines and it is necessary to use, in making these comparisons, expressions for the boiler capacity and steam consumption respectively, which put those two factors on a fairly even basis on different types of engines, otherwise we are greatly restricted in the number of examples which we can employ as a basis of our comparison. I think the method shown in figure 1 of plotting ratios by classes, gives in a graphic way a very clear idea of the comparative figures for a large number of engines. Now, when plotting in this way the relation between the steam consumption of the engine, which is expressed by T. D., and the boiler capacity expressed in square feet of heating surface, I felt that we were not using a comparison which was of any value when applied to different types of engines. The engines in which this ratio was low and which therefore should, according to our generally accepted ideas, be good steaming engines, were not as good steamers as some of the older engines with shorter flues on which this ratio was considerably higher. I do not think there is any doubt but what the factor T. D. represents the steam consumption of the engine very satisfactorily; it is not of course absolute, as it does not take into account whether the packing rings are tight or leaky, but it is a good comparative figure and we must therefore look for some better way of expressing the boiler capacity than by merely using the total square feet of heating surface. The formula developed in this paper represents an attempt to do this. The description of this formula may look a little complicated, but I think if it is studied carefully it will be seen to be comparatively logical. We know that there is a great difference between the evaporation in the first few feet of the tube and the last few feet; that proves that the length of the tube, or in other words, the actual number of square feet of heating surface in it is not entirely a fair measure of its evaporative capacity. I have employed in place of the length, the square root of the length. It is possible that this is not entirely accurate, but we do know that it is probably far more accurate than using simply the length and you see that by the analyses of the Petiet experiments, which correspond very closely with the actual results obtained in those tests. If the tube heating surface were all that went to make up a boiler, this change would be sufficient, but we have frequently heard the statement that the firebox is the biggest part of the boiler, and I believe this to be true. Now the firebox is not nearly as large in comparison to the boilers in modern engines as it used to be in those built 10 to 12 years ago, and it does not look rational

to assume, as we have been doing, that one square foot of heating surface has the value of one square foot whether it is in the firebox or the front end of the tubes. The question arises, how are we going to allow for the difference in value between firebox heating surface and tube heating surface, and I have attempted to do this by noting that the boiler used in the Petiet test was of very closely the average design of our older engines, that is to say the proportions between the tube heating surface, firebox heating surface and grate area were such as we commonly employed in regular American practice; in those experiments also when the tube heating surface is expressed by multiplying the circumference of the tubes by the square root of their length we find that each equivalent square foot of heating surface was equal in evaporative capacity to 1 square foot of firebox heating surface, so that if we divide the figure arrived at for equivalent heating surface, by 2, we should express it in firebox heating surface. The next point to be considered is that as the firebox grows smaller and smaller in proportion to the heat developed by the fire, it absorbs less of that heat and more must be taken up by the tubes. Now, if the formula derived from what I call the equivalent heating surface of a boiler by these methods is applied to the same engines which give unsatisfactory comparisons under the old system, we find that the comparisons obtained are satisfactory and that the ratio T. D. divided by h, where h is the equivalent heating surface, represents fairly well whether the engine for which it is calculated is a good steamer or not. With reference to the latter portion of the paper, it has occurred to me from the facts brought out in connection with the Petiet tests, that perhaps the whole question of steaming capacity is more complicated than we have so far thought it to be, and that our ideas upon heating surface should be somewhat modified; given, for example, a certain number of pounds per hour being burned properly on a grate, a certain amount of heat will be given off. If there were only 1 square foot of heating surface in the boiler it would probably evaporate 60 lbs. of water per hour and the rest of the heat would be wasted. If there were 2 square feet you would evaporate 120 lbs. per hour, and each additional square foot of heating surface would evaporate the same amount. After a time, however, the addition of a square foot would mean not 60 lbs. of water evaporated, but a smaller figure. (The speaker endeavored to explain this more clearly at the meeting, but was unable to make a diagram illustrating his ideas owing to there being no blackboard. The diagram has been sent by him since with a request that it be incorporated to illustrate his views and his remarks have been modified accordingly. See Figure 9.) This can be illustrated more clearly. Suppose that we have a given amount given off by the coal, and that on this diagram we plot the percentage of the heat utilized in evaporating the water on the vertical lines, and the square feet of heating surface on the horizontal lines; the dotted line represents the amount of heat that would be utilized, supposing each

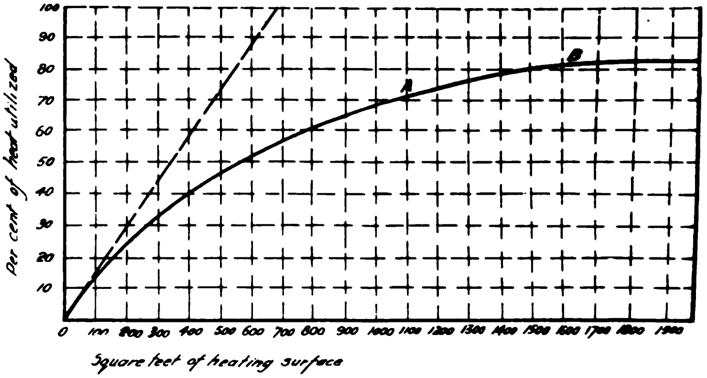


Fig. IX

square foot of heating surface added to evaporate as much water as the first square foot. The full line represents more closely what actually takes place, showing the gradual diminution at the rate at which water is evaporated per square foot as we increase the total amount of heating surface. According to this, after we have passed the point A on the diagram, doubling the amount of heating surface would only increase by a small amount the water evaporated; and if we assume the average locomotive to be at about the point B, we can understand why quite a considerable difference in heating surface will not affect very largely the steaming capacity of the engine, provided it is not decreased in such a way as to affect the amount of coal that can be properly burned. The question of the amount of coal that can be burned, apart from the fireman, depends on the draft on the front end which, in its turn, varies with the back pressure and the pounds of steam discharged per hour; it also depends upon the ash pan opening, the resistance of the fire on the grate, the flue area and the obstructions in the front end. Now suppose that an engine is a good steaming engine, with a fair fireman, decrease the ash pan opening considerably to burn the same amount of coal and evaporate the same amount of water, you will have to apply a smaller nozzle so as to obtain the necessary draft to overcome the increased resistance of the air entering the ash pan. This means more back pressure and a greater steam consumption to do the same amount of work, so that it will be actually necessary to evaporate more water and burn more coal than was the case previously. The same reasoning would apply to a change in flue area or to the poorer diaphragm arrangement in the front end. Now, if a decreased nozzle burns sufficient coal to furnish the additional amount of steam required under these conditions, that engine would still be a good steamer; but if the amount of reduction required is so great that the additional steam consumption more than overcomes the additional coal burned, you have a condition where the engine changes from a good steamer into a poor steamer. You will, no doubt,

say that engines are not nearly as sensitive as this, but we must consider the fireman in this proposition. If the engine had originally been a good steamer with a comparatively thick fire, the change in the diaphragm or in the ash pan could have been overcome by the fireman carrying a thinner fire and reducing the resistance at the grate sufficiently to still allow the original amount of draft in the front end to burn the same amount of coal. This change might, however, have been made at the expense of the economy of the engine and you have a condition which frequently obtains, viz., that an engine is a good steamer when carefully fired, but is liable to give trouble without such attention. I do not think the data is as yet at hand to formulate this point of view about the locomotive, but I believe if we could get down to facts on this subject we could put the question of steaming capacity of locomotives on a thoroughly sound basis, and we should find that the amount of heating surface made but little difference in our calculations.

THE CHAIRMAN: The secretary has some communications which he will read.

THE SECRETARY: Mr. Chairman, I have one communication from Mr. William Forsyth.

MR. WM. FORSYTH (Railway Age): In Mr. Vaughan's study of the subject he concludes that in the large locomotives built in 1903 the rate of evaporation per square foot of heating surface is not the same as in older locomotives where the proportion of tube heating surface was smaller. He then endeavors to find a measure of the actual value of heating surface of tubes of various lengths, and proposes a formula which will give the equated heating surface of firebox and tubes which will take account of different ratios of tubes and firebox surface. To determine the equated value of tubes of different lengths he uses the data obtained in the experiments by M. Petiet on the Northern Railway of France in 1865, and from them concludes that the evaporation per square foot of tubes of any length is the same if the square root of the length is taken, instead of actual length, and if this be divided by two, a value is obtained which is equivalent to the same area of firebox heating surface.

While the author is not satisfied with the method of allowing for the variations in the ratio of firebox and tube heating surface, he believes that the square root of the length of tubes is the correct way to estimate their value in evaporating capacity.

It would be a matter of great satisfaction if locomotive designers were sure that this is correct, but there is nothing in the regular performance of locomotives to confirm it, and no experiments have been made which are adequate to a proper proof of the correctness of the hypothesis. In fact, there are good reasons for believing that the law cannot have general application, as the efficiency of tube heating surface depends much on the spacing of tubes as well as their length, as has been shown in the marked change in the number of tubes and reduction in total heating surface in recent engines where the spacing of

tubes has been largely increased and where equal boiler capacity is expected from a reduced tube surface. The author calls attention to the good steaming qualities of the Pennsylvania Railroad Class E-2 engines, which have nearly 1,000 square feet less total heating surface than other engines of the same type, size and weight. This is not due primarily to the fact that the Pennsylvania Railroad engines have a less number of tubes or less heating surface, but because the tube surface is favorably disposed (in its wide spacing) for maximum efficiency.

The formula cannot have general application to passenger and freight locomotives, for it is well known that the efficiency of tube heating surface depends upon the period of contact of the hot gases with the tube surface and the velocity of the gas current is, therefore, to be considered in measuring tube efficiency. The greater the velocity the longer should be the tube, and for conditions found in very fast express locomotives, it is not possible to use a tube long enough to obtain the maximum theoretical efficiency. The value of long tubes for such service is shown in their successful and continued use in recent passenger locomotives of the Pacific type, while they would not prove so efficient in freight engines.

It may be said that the proposed square-root law should apply to boilers having tubes of the same diameter, having the same spacing, but different lengths. For any evidence of the correctness of this application we must depend upon the results of special experiments, and the absence of any such work in recent years compels the author to refer to the work of M. Petiet in 1865, and he states that he is not informed as to the objections that have been made to Petiet's experiments. The description of these experiments as given in D. K. Clark's "Steam Engine," shows that the barrel of the boiler was made up of four separate drums, each about 3 feet long, and each closed with tube plates. These were bolted together, so as to be steam tight, and thus made up the boiler barrel 12 feet long. The firebox and each of these sections was fed from a gauged tank by special pumps and the water levels were maintained strictly uniform. It is in this unusual construction and method of conducting the experiment that the most serious sources of error occurred. The circulation of water in a boiler made up in this way is entirely different from that in one as generally used, and the efficiency of the heating surface in the different compartments must have been affected by the rate of water circulation. In the firebox where heat was intense the water boiled violently and set up active circulation, which, in turn, increased the evaporation per unit of surface, and this showed a very high efficiency in that section. In the different tube sections the temperatures of the gases decreased toward the front and with it the intensity of the ebullition, and in the front section the circulation must have been very sluggish and more so than in a normal boiler without partitions, which tended to decrease the evaporative efficiency per unit of surface. It is true that this tendency exists in

a regular boiler without vertical partitions, but it still has the advantage of the average circulation of the whole boiler, the water flowing rapidly from front tube sheet to firebox to supply that which is being rapidly converted into steam passing off through the throttle. The test boiler of M. Petiet did not, therefore, represent actual conditions in regard to water circulation, and, in fact, its artificial arrangement tended greatly to aggravate the very change in rate of evaporation which he wished to measure. His results cannot be accepted as sufficiently accurate to serve for the basis of a formula intended to equate the heating surface of tubes of various lengths. The experiments of Yarrow and Thornycroft and others have shown that the efficiency of heating surface depends upon the velocity of water current, and that maximum efficiency can only be obtained by forced circulation by mechanical means. It is for these reasons that we must disregard the results of M. Petiet's experiment and also those of M. Henry (which were made in the same kind of a boiler as late as 1889) in the effort to find a general expression for the actual value of boiler heating surface.

THE SECRETARY: I also have a communication, Mr. Chairman, from Mr. Lawford H. Fry, who read a paper on the same subject before the New York Railway Club last September, to which Mr. Vaughan refers.

MR. LAWFORD H. FRY (Baldwin Locomotive Works): I am glad to see that Mr. Vaughan calls attention to the fact that the factor B D measures the amount of water which must be evaporated per square foot of heating surface. This view of the factor gives probably the clearest idea of its real meaning. When two locomotives are working under similar conditions the demand for steam made by the cylinders on the boiler is in each case directly proportional to the value of B D. It has occurred to me that it might be well to use the term Boiler Demand factor as a correct name for the factor B D, and one which would provide a link between the name and the property of the factor. In my paper, read before the New York Railroad Club last September, I pointed out that the factor B D could only be used as giving accurate comparisons between locomotives having boilers of similar design. Mr. Vaughan now points the way to a wider and more accurate method of comparing the steam-making capacity of boilers of various designs. I am much interested by Mr. Vaughan's conclusions, as I have been attacking the same problem from another direction and have come to much the same results. There appears to be only one point to be questioned, and that is the constant used to take account of the firebox heating surface. It is undoubtedly true that in the flues the heat absorbed is very nearly proportional to the square root of the distance traveled by the gases; but is it safe to assume that the formula given at the bottom of page 5 holds for any boiler beside that on which M. Petiet's tests were made? Mr. Vaughan's paper gave me a clue which, in connection with some work already begun, has given the following formula for the evaporative power of a locomotive boiler:

$$V = 180\,G + 40\,\sqrt{\frac{S.\,St}{L}}$$

V = Water evaporated by the boiler per hour in pounds.
G = Grate area in square feet.
S = Total heating surface, firebox and tubes, in square feet.
S_t = Heating surface of tubes.
L = Length of tubes in feet.
S_f = Heating surface of firebox.

I regret that lack of time prevents me submitting for the criticism of the Western Railroad Club the full details of the development of the formula, but I offer for consideration the form of the expression and the following general principles on which it is based:

The heat generated on the grate is carried to the heating surface in two ways: Firstly, by direct radiation from the glowing coal, and secondly, by the heated gases produced during combustion. The radiated heat cannot be taken up except by the firebox heating surface. The heat carried by the gases is transferred by them to both the firebox and the tube surfaces. Peclet's formula given in "The Steam Engine" by D. K. Clark, enables one to calculate the respective amounts of heat taken from the grate by radiation and by the hot gases.

If coal of about 14,900 B. T. U. is burnt at the rate of 130 pounds per square foot of grate per hour, it will be found that of the heat generated 16 per cent is radiated and 84 per cent is carried off by the hot gases, the temperature at the fire surface being about 1785 deg. F. The heat radiated per square foot of grate surface figures out at sufficient to evaporate 201 pounds of water per hour from 60 deg. F. to 180 pounds boiler pressure. This gives the first term of the formula, the constant being reduced 10 per cent from 201 to 180 to give conservative figures. The first term, $180\ G$, takes account of the water evaporated by the radiated heat. The seconn term, $40 \sqrt{\frac{S.\ S_t}{L}}$, is designed to take account of the evaporation due to the heat carried by the gases. This heat is transferred to the firebox and to the tube heating surface, the amount absorbed being nearly proportional to the square root of the distance traveled by the gases. It appears proper to treat the firebox surface as if it had the same section as the flues. That is to say, to use for the length of the firebox that length which the same amount of Heating Surface in the flues would have. This length is $\frac{S_f\ L}{S_t}$, so that the whole length is, $L + \frac{S_f\ L}{S_t}$; this gives as the effective heating surface $\sqrt{\frac{S.\ S_t}{L}}$ Now with combustion conditions as assumed above and a boiler of average dimensions, it is found that each square foot of effective heating surface will absorb sufficient heat to evaporate 40 pounds of water per hour. The total evaporative power of the boiler is then

found by combining the two expressions into the form given above. The following table shows the application of the formula to 3 locomotives. The results given appear reasonable. It is quite probable that the constants in the formula will require some readjustment by comparison with the results of actual tests. Since obtaining the formula I have not had time to make any extended comparison with test figures:

	1.		2.		3.	
Heating surface tubes...... S_t	2914	sq. ft.	2225	sq. ft.	2734	sq. ft.
Heating surface firebox..... S_f	141	"	135.5	"	169	"
Heating surface total....... S	3055	"	2360.5	"	2903	"
Grate area ....G	42.0	"	33.0	"	46.5	"
Length of tubes............L	$18'3\frac{11}{16}''$		13'0"		15'0"	
Water per hour by formula. V	35,350	lbs.	31,400	lbs.	37,460	lbs.
Water per sq. ft. of heat. surf. $\frac{V}{S}$	11.75	"	12.85	"	12.9	"

The last line of the table is obtained by dividing the calculated water by the total heating surface.

The figures obtained above for the amount of heat radiated from the fire suggest an explanation of the trouble experienced with wide fireboxes having a heating surface small in comparison to the grate area. The amount of radiant heat depends on the area of the grate, and must all be absorbed by the firebox surface irrespective of size. Taking the Lake Shore engines described by Mr. Vaughan, considerable difference will be found in the duty required of the firebox surface. The Q-4 engines have 9.4 square feet of heating surface to each square foot of grate; so that if each foot of grate radiates enough heat to evaporate 180 pounds of water, each foot of firebox surface will absorb enough to evaporate 19.2 pounds per hour. The class J engines have only 3.9 square feet of firebox per foot of grate, so that the firebox evaporation from radiated heat will amount to 46.2 pounds per hour. It would be interesting to know how the two fireboxes compare in service.

THE SECRETARY: Those are the only communications, Mr. Chairman.

THE CHAIRMAN: The papers are before you for discussion, gentlemen.

MR. C. A. SELEY (C., R. I. & P. Ry.): Mr. Chairman, I can't say very much about the paper at this time, except to commend it as a very good contribution to the science of locomotive engineering. It is too deep for criticism with the limited time I have had for its examination. How far we have lost in most effective heating surface in making fireboxes shallower, as is necessitated in many modern designs, is shown by the loss of efficiency which this paper enables us to gauge more accurately than heretofore. The subject is one requiring much study, and I must confess that I am not in shape to discuss it further.

MR. F. H. CLARK (C., B. & Q. Ry.): As Mr. Seley has said, the paper needs a great deal of study to enable one to intelligently discuss it. It treats of a very important matter and one that we have all had to think of more or less, especially as on our recent engines we are get-

ting longer tubes and more of them. I believe he is entirely correct in the idea that we have attached too much value to heating surface, especially to tube heating surface, and in some cases we have got too many tubes in our boilers to get satisfactory results from them. I don't know about the matter of grate area—I have not given that any particular consideration in this connection—but one thing that we have considered, and on which we have come to a conclusion, is the matter of circulation. I feel that we have paid too much attention to the amount of heating surface and not enough to the freedom of circulation in the boilers, and that in many instances we actually gain by taking out a number of tubes. We have gone as far as 10 or 12 per cent in reducing the number of tubes in our later engines with very good results; the engines not only steam as well or better and are just as economical, but we get a much better circulation and reduced flue failures. I am very glad, therefore, that Mr. Vaughan has brought the matter up in the way he has, and questioned the value of the very large heating surfaces we have. I think he is on the right track.

THE CHAIRMAN: Is there any further discussion? If not, we will ask Mr. Vaughan to reply to these remarks, if he desires.

MR. VAUGHAN: I wish Mr. Forsyth were here so that I could make a little better answer to his remarks. Mr. Forsyth says that there is nothing in the regular performance of engines to confirm what I have said. Well, what I have said is based on the regular performance of engines. It is based upon the performance of engines with which I am familiar, and it would appear to me that the value of the formula is proved by the fact that it does give results in comparison with the actual results in service. No formula can do more than that, and I have no hesitancy in stating that while the one I suggest may not be perfect, it is safe to use it with the feeling that you can depend on the results you obtain from it far more closely than you can from the results obtained from our previous methods. Mr. Forsyth refers to the spacing of the tubes; no doubt this is a factor and one that is not taken into account in the formula. I would also state that I have not taken into account the question of whether there is any fire in the boiler or not; I have not taken into account the amount of grate area in the formula for heating surface, and have not attempted to take into account all the variations possible in a locomotive boiler. I have simply tried to allow for variations in length of flues and proportion of firebox heating surface so as to bring boilers of these different types down to the same basis so far as heating surface is concerned. Mr. Forsyth states that the good steaming qualities of the P. R. R. engines are due to their tube spacing. I do not think that Mr. Forsyth has any right to more than an opinion on this subject. I do not wish to minimize the importance of this flue spacing, but I do not think the question is in such a condition that any one has a right to make a positive statement with reference to it. On the Lake Shore we made some experiments on this subject

which are quite interesting. The class J engines originally had 2¼-inch flues, 3-inch centers; in order to obtain a wider bridge we built two engines having 2-inch flues, on the same centers. There are also eight other engines having 2-inch flues, 2¾-inch centers. There is no doubt that the engines having 2-inch flues and 3-inch centers were the poorest steamers of the lot, and the engines having the 2¼-inch flues were the best steamers, although they had less heating surface and the same bridge as the engines having 2-inch flues and 2¾-inch centers. In fact, Mr. Ball has told me that on their next engines they will go back to the 2¼-inch flues. I explain this by the fact that the changes from 2¼-inch to 2-inch flues decreased the flue area considerably, and that in order to burn sufficient coal it was necessary to contract the nozzle. In fact, with the engines having 2-inch flues and 3-inch centers we had to run the nozzle ⅛ inch smaller than on other engines. I have compared the relations between the flue area on these different engines and their steam consumption with the two conditions in M. Petiet's experiments in which all the flues and part of the flues were in use, and find that on the basis of his tests the engines having 2-inch flues and 3-inch centers would burn 10 per cent less coal with the same draft than the engines having 2¼-inch flues, and I think you can safely assume this is very closely what took place. Mr. Forsyth refers to the continued use of long flues in the Pacific type passenger locomotives. I would simply state that if Mr. Forsyth can suggest any successful method of building Pacific type passenger engines without long flues, he will give the railroad world some much desired information. Mr. Forsyth also criticizes the Petiet experiments on account of the lack of circulation, and I realize that there is something in this criticism, but he does not suggest any method by which such results can be obtained which would be free from this objection, and, for my part, I do not see how it would be possible to do so without very great expense. I am also very doubtful whether the conditions in the boiler are not so closely comparative with those in the Petiet experiments that we can use the latter as an indication of evaporation in the boiler without very serious error, and you must remember that the chief point at issue is not whether the square root length is right, but whether it is more nearly right than the actual length, and I believe that the results that I have shown you by using this factor on actual engines prove that it is, and it is now somebody else's part to give us a better one. I do not think that Mr. Forsyth is justified in stating that we must all discard the experiments that I refer to simply because he is not entirely satisfied with the conditions under which they were carried out. If you like, you can forget all about these experiments and assume that the formula I have proposed is entirely empirical; the fact is, that it gives you the results you want, and that is all I am interested in. I would state that I am very much interested in this subject, and that the only way, in my mind, to settle whether this formula is correct is to compare the results obtained by using it

on engines in service, with their actual performance. I would be very glad if our members would plot for their own engines the ratios I have shown in the diagrams in my paper and let me have a copy of them, and I shall take great pleasure in acting as an intermediary in collating these results.

MR. CLARK: Mr. Chairman, I don't want to be understood as favoring what might perhaps be called an excessively wide bridge. We at one time tried some experiments similar to those Mr. Vaughan speaks of, and I think in applying new tube sheets we put in about the same number of 2-inch tubes that we had of 2¼-inch tubes before. The results were not at all satisfactory. I am rather inclined to think that a bridge of ¾ to ⅞ inch is wide enough. We have a great many engines running with ⅝-inch bridges, quite a number 11-16-inch and a few of ¾-inch and I don't feel that we need go any further in that direction. But what I had in mind when I got up before was the lack of space in many boilers between the tube and the shell. I know that we have in past years tried to get in as many tubes as we could. We would space them out as close to the flange of the tube sheets as we dared, and the result was we got so many in that we hadn't room between the tubes and the shell to permit of proper circulation. We find now that by taking out a few of the outside tubes and increasing the space to 4 or 5 inches, we get very much better results, and without any change in spacing the tubes.

MR. JAS. F. DEVOY (M. E., C., M. & St. P. Ry.): Mr. Chairman, will you pardon me at this time for taking this up, but I have been working along this line for some little time. I was interested in Mr. Vaughan's remarks as to what he would do to apply the rules to the modern locomotive. I am quite familiar with the Lake Shore J engines, having worked on them at the time they were being designed, and I am now working up or have under consideration means to overcome some of what I believe to be the defects. I would speak first of the length of the flues. I think we can get a flue, for instance, 16 feet 6 inches long, instead of 19 feet and 20 feet, which are the case in the later engines of the Lake Shore, but in order to do this and maintain the heating surface of the flues I believe that it would be better to set the flues higher; that is, nearer the dry pipe. The objection has always been against putting flues higher in the boiler, that the steam space was destroyed. Now, I propose to go on up with a wagon-top of boiler, that is, provide for more steam space; we will put the offset 5 inches instead of 2¼, which is the case with the J engines. This will bring another objection, and in this manner it will bring the center of gravity of the boiler or the engine higher. In order to overcome that we must bring the grate lower. I contend that the 54-inch trailer today used on nearly all of the Atlantic type engines (they run as low as 42 inches) will be brought down to a 33-inch, or not more than a 30-inch wheel, which will make it the size of the wheel under the forward truck. I see no objec-

tion to that. My reason for doing that is to bring the firebox down lower, that is, bring it down right where we started from. I contend we are entirely too high and that we have gone to a too shallow firebox, that is, it sets up too far; bring the mud ring of the boiler down so that you are 12 to 14 inches below the top of the frame. In order to do this it would be necessary to go to a narrow firebox. In order to maintain the grate surface it will be necessary that the throat sheet of the boiler extend forward to about the center of the rear driver. I speak now of the Pacific type engine. Instead of a wide firebox, with a sloped throat sheet coming back over the rear of the drivers, that you set it ahead and drop it down just as close to the back pedestal as possible, carrying the boiler down just as low as possible, and get over a 33-inch trailer. This will necessitate a longer firebox. In order to get 10 or 12 inches off the length of the firebox, for instance, a 10-foot firebox, 120 inches, I would make that 6 or 8 inches longer, and in order to shorten up the space in which the fireman shall throw his coal, that we might overcome the old objection that a man can't fire a 10-foot or 10-foot 6-inch firebox, that the back head of the boiler shall be sloped about 1 inch in 5, placing the door, the firing door, about 10 inches higher than it was, that is, 10 inches higher in the new design than what it was in the old. My reason for that is that the back end of the boiler shall slope about in that shape, about that position (indicating), that represents the grate (indicating). We will put the door up here, within about 10 or 11 inches of where the man has got to throw the coal.

Now, I have tried to apply these rules, and in going over them, these are the things that I met with. I believe that a successful engine will yet be designed, and that we are going right back to where we started from, that is, to a narrow firebox, a longer one, and try to shorten up the firing space and shorten up the flue. I don't believe that a flue 20 feet long pays for itself; that is, I mean the last two or three feet after you have passed 16 feet. In experiments in a test that I conducted some years ago with a flue 15 feet long, the average temperature of the gases in the smoke box was about 567 deg.—it was as low as 440 deg. Now with steam at 200 lbs. pressure, I think you will find it 390 deg. or something near that, and I say that the steam generated at that point does not pay for the effort. We shall go back—we shall shorten our flues in that manner.

I don't know that this just applies to Mr. Vaughan's paper, but it is simply what I have been working at along those lines in my own mind.

THE CHAIRMAN: Are there any further remarks? Mr. Vaughan, do you wish to reply?

MR. VAUGHAN: No, sir.

THE CHAIRMAN: If there are no further remarks, we will close the discussion on this paper.

We have been considerably delayed on account of our having too

much light for the stereopticon views. We will see now if the arrangements are completed so that we can have the lecture on the "Steam Turbine." I take pleasure in introducing Mr. C. G. Y. King, of the Commonwealth Electric Company.

THE SECRETARY: Owing to the fact that it is impossible to get copies of the illustrations thrown on the screen for reproduction in the proceedings, Mr. King's interesting talk must be omitted from our proceedings. It is with much regret that it is necessary to do this.

Adjourned.

OFFICIAL PROCEEDINGS

OF THE

WESTERN RAILWAY CLUB

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The regular meeting of the Western Railway Club was held at the Auditorium Hotel on Tuesday, May 17, 1904, President D. F. Crawford in the chair. The meeting was called to order at 2:30 p. m.

Among those present, the following were registered:

Anderson, Geo. T.	Garrett, M. A.	Mylett, Jas.
Averill, E. A.	Gilbert, E. A.	Noble, L. C.
Barnum, M. K.	Goehrs, W. H.	O'Herin, Wm.
Bell, J. M.	Gold, E. H.	Otis, Spencer
Bennett, F. F.	Hagar, G. A.	Otley, B. F.
Bischoff, G. A.	Haig, M. H.	Parish, Le. Grand
Bodler, O. W.	Harris, E. K.	Parker, W. R.
Brooks, P. R.	Harty, J. W.	Patterson, J. B.
Brown, R. L.	Hill, Jas. W.	Peck, P. H.
Carney, J. A.	Holdredge, C. B.	Replogle, J. L.
Coffin, G. B.	Hooven, A. E.	Ross, Mark A.
Cooke, M. J.	Humphrey, A. L.	Sargent, F. W.
Cota, A. J.	Jackson, Thos.	Senger, J. W.
Cross, C. W.	Keeler, Sanford	Shantz, O. S.
Crossman, W. D.	Kirby, T. B.	Sherman, L. B.
Cushing, Geo. W.	Kucher, T. N.	Schroyer, C. A.
Deming, H. V.	LaRue, H.	Smith, R. D.
DeRemer, W. L.	Lewis, B. T.	Stimson, O. M.
Duntley, J. W.	Linn, H. R.	Sullivan, C. L.
Duntley, W. O.	Maher, P.	Symington, E. H.
Eames E. A.	McAlpine, A. R.	Taylor, Jos. W.
Edwards, F. W.	Markle, J. R.	Templeton, W. S.
Fergusson, H. O.	Meek, J. E.	Thurnauer, Gustav.
Fogg, J. W.	Mellon, W. P.	Vissering, Harry
Forsyth, A.	Menzel, W. G.	Walker, Chas. W.
Fry, Jr., C. H.	Midgley, S. W.	Webb, E. R.
Fury, F. W.	Morison, G. D.	Webster, H. D.

Wickersham, R. S.	Wood, G. S.	Younglove, J. C.
Wilson, C. E.	Young, C. B.	Zeleny, Frank
Wilson, G. L.		

PRESIDENT CRAWFORD: The first business is the approval of the minutes of the last meeting, and if there is no objections, they will stand as printed.

Next is the report on membership.

The Secretary then read the following report:

Membership, April, 1904	1,085
Resigned, G. L. Olhausen, Jas. A. Britt	2
New members approved by Board of Directors	8
	1,091

NEW MEMBERS.

NAME.	OCCUPATION AND ADDRESS.	PROPOSED BY.
Frank N. Kneas,	Cambria Steel Co., Chicago	J. L. Replogle.
N. L. Moon,	T. M., Dela. & Hudson Co., Carbondale, Pa.	M. E. Johns.
W. E. New,	G. F., C., R. I. & P. Ry., Trenton, Mo	A. T. Cunningham.
T. E. Epler,	Genl. Shop Insp., L. S. & M. S. Ry., Collingwood, Ohio	LeGrand Parish.
T. H. Goodnow,	C. C., L. S. & M. S. Ry. Shops, Chicago	LeGrand Parish.
C. A. Carscadin,	Monarch Coupler Co., Chicago	A. L. Humphrey.
Chas. Shults,	Nathan Mfg. Co., New York	Sanford Keeler.
K. D. Hequembourg,	Franklin Ry. Supply Co., Franklin, Pa.	W. J. Cooke.

PRESIDENT CRAWFORD: Next will be the paper on "Steel Axles," by J. L. Replogle, of the Cambria Steel Company.

MR. REPLOGLE: Mr. President and Gentlemen of the Western Railway Club: It was with considerable trepidation that we accepted an invitation to read a paper on steel axles this afternoon. We realized we were talking to men of experience in this line and we naturally felt some hesitancy in talking to you on this subject. We are a nation of specialists, however, and it is but reasonable to assume that any man who applies himself almost constantly to this, or any other particular subject, might learn some things regarding which, the railroad man with his many other cares and troubles could not familiarize himself.

STEEL AXLES.

By J. L. Replogle, Supt. Forge and Axle Dept., Cambria Steel Co.

Can too much importance be attached to this, the most important part of the rolling stock of the railroad systems of today?

Which other portion of the car or locomotive has more important functions to perform than the axle?

Upon which other portion does the protection of life and property depend to so great an extent as it does upon the axle?

Upon the care with which its proportions are calculated, its shape designed and its manufacture carried out depends, to a great extent, the successful working of the rolling stock and the transportation of the products of our country.

The railroads of a country are indicative of its strength, resources and importance. Has any one thing been more responsible for our commercial supremacy than the excellence of our railroad systems and the men to whom the high degree of efficiency found therein is due?

In which other country do we see solid trains of cars, the lading of each of which approximates, and may exceed, the marked capacity of 50 tons?

Would this condition have been possible without the substitution in the working parts, of metal with greater strength, tenacity and resiliency than unreliable iron of low elasticity and tensile strength?

The comparative merits of steel and iron for car axles is a question which has engrossed the attention of railroad officials and axle makers for many years. We feel justified in saying that the experience of these years has demonstrated that steel is superior to iron for this purpose, not only on account of its greater power of resistance against the shocks and vibrations to which it is subjected in service, but also on account of its greater wearing properties, the friction being less than in the iron axle, where lack of sufficient heat, presence of scale, or other conditions often prevent perfect adhesion of the various constituent parts. Even a perfectly welded iron axle will not allow the high polish and minimum amount of friction obtainable in the steel axle of the proper composition.

Our secretary, Mr. Taylor, has suggested that we divide our paper into sub-heads, as follows:

A—Method of manufacture.

B—Our opinion as to best specification, chemically and physically, and a review of the present Master Car Builders' specifications.

C—What we have found as a result of the examination of broken axles.

METHOD OF MANUFACTURE.

A—In the early days of steel axles, the steel maker had difficulty in proving the superiority of his product, as there were numerous break-

ages in service for which he could not account, his chemical analysis indicating that the elements were of the proper proportion to the evident requirements of the purpose. In looking for the cause, he found that while his light hammers of probably 2,000 pounds falling weight were sufficiently powerful for building up iron bars probably one to two inches thick into an axle of approximately 5½ inches diameter, it was entirely inadequate for forging steel axles, as steel, not possessing the welding properties of iron, could not be forged in the same manner.

Instead of building up from bars one to two inches thick, he was compelled to reverse the method, and hammer down from a billet about twice the size his finished forging should be.

His hammer not being sufficiently powerful to penetrate throughout the mass, did not give the axle that homogeneous structure so essential in a forging subject to the heavy alternating stresses which a car axle undergoes in service. The internal condition of his axle was revealed to him by the end of his rough forging, which was a deep concave, showing that the surface metal only had expanded and that the inner portion had not received the proper working and consequent homogenity of structure which he desired. It also showed inclination to "pipe."

He appreciated his position and promptly strengthened it by the installation of heavier hammers of about three times the weight formerly used. While he immediately saw a distinct improvement in his forging (the end now being convex, indicating that the inner portion had received proper attention), the steel axle did not give the absolute satisfaction of which he thought it capable, and an investigation proved to him that heat treatment in the forge was largely responsible.

He reasoned that as no two parts of the axle were forged at the same temperature, internal strains had set in, which were very detrimental to the forging, and which would have to be relieved. This was particularly evident in locomotive driving axles, which, after cutting key-way, thereby relieving strains in the fibers, would often become distorted.

To relieve the injurious strains above stated, he resorted to annealing. By heating the forging to a temperature slightly above the recalescent point (which, in steel of carbon usually found in axles, would be approximately 1,200 deg. Fahr.), he eliminated all crystallization resultant from the cooling from the forging temperature of about 1,800 deg. Fahr. and a fine amorphous structure was obtained.

Crystallization would of course set in again when forging was being cooled, but as in the annealing he did not approach within 400 deg. or 500 deg. the temperature at which his axle was forged, the resultant crystallization was comparatively small. While the ductility of the annealed forging was greatly increased, it suffered a slight loss in elasticity.

Realizing the importance of having a high degree of elasticity in his material, which was continually subjected to severe alternating

tension and compression, and often torsional strains, the axle maker started to experiment with a view of not only maintaining the elasticity found in the original forging before annealing, but also to increase same.

Various methods have been used to gain this result, among the more prominent being the "Coffin Toughening Process" and "oil tempering and annealing," either of which give the following results:

1.—The elastic limit is increased to a marked degree.

2.—The percentage of elongation and reduction of area are greatly increased.

3.—A remarkable degree of toughness is obtained.

4—Steel changes from a crystalline to an amorphous state.

5.—Internal stresses are eliminated.

6.—Uniformity of structure and strength are obtained. The increase in elasticity is of the greatest possible benefit as it is a recognized fact that once the elastic limit of metal has been passed and forging therefore distorted, it cannot be depended upon to sustain even minor loads.

In wrought iron forgings the elastic limit probably does not exceed 20,000 lbs. per square inch. Steel of say .45 carbon, properly treated, will show almost three times as much elasticity and is, therefore, much better fitted for the service described.

Realizing that in material of this kind wherein so much depends, that "the best is none too good," the modern steel manufacturer has installed complete chemical, physical and microscopical laboratories which tell him the results obtained throughout the various stages of manufacture, and in the final treatment at the annealing furnace he raises or lowers the physical properties to the required specifications, carefully and intelligently guided by reliable pyrometers which show the operator the exact temperature of his furnace at any and all times.

"The method of manufacture," then, we consider of great importance. Our claim that a steel axle properly forged and afterward properly annealed is infinitely superior in strength or wearing properties to the best iron axle, we think can hardly be disputed.

While the art of steel making has been perfected more and more year after year, the material and skill for making the best quality of iron have, on the contrary, retrograded, and at the present time a good grade of iron is scarce, largely on account of the difficulty in obtaining the necessary good quality of scrap, that now available being composed of inferior iron intermixed with pieces of steel of various grades, which produce imperfect welds and irregularities in the finished axle.

This lack of homogenity permits the torsional strains and friction to separate the fibers of the metal;—longitudinal seams and rough spots develop which finally result in failure of the axle.

SPECIFICATIONS.

B—Our opinion as to the best specification would be an endorsement

of the present Master Car Builders' specification, with a few exceptions, viz.:

1—We should recommend an increase in carbon, making the limit .40 per cent to .55 per cent instead of .35 per cent to .50 per cent as at present. This would insure greater wear, permitting a higher polish with a consequent reduction of friction, and, if properly treated, greater strength, but would necessitate a slight modification of the present drop test.

2—We should insist upon all axles being thoroughly annealed, as by this method only, is the true strength of the steel represented.

3—We would adopt a "maximum weight" clause compelling manufacturers to rough turn forgings on journals and wheel seats to within ⅛ inch of your finishing dimensions, thereby eliminating the necessity of your paying for 50 to 75 pounds of excess material per axle, which also necessitates a vast amount of extra work and expense at the railroad shops, subjecting your lathes to both roughing and finishing duties, which is detrimental to the best results in fitting.

4—We should recommend a maximum limit on phosphorus of .05 per cent instead of .07 per cent as at present, to compensate for the recommended raise of the carbon limit by five points, both elements being hardeners, but carbon affecting the ductility less than the phosphorus, and being conducive to greater wearing qualities.

5—We would modify that portion of clause 1 in the specification relating to the rough turning of axles to read: "Axles must be rough turned on journals and wheel fits to within ⅛ inch of finished dimensions and must be smooth forged between wheel fits."

Rough turning a car axle between wheel fits robs the axle of the tough surface skin which is a very valuable asset.

In this connection, I would cite results of a test made at our works to demonstrate our claim: During a controversy with an inspector of a prominent railroad which specifies rough turning all over, we suggested to him that he take two axles of the same heat, one being rough turned to 5⅞ inches in center, the other being smooth forged to same dimension. These axles were subjected to same treatment throughout and were then tested to breakage. The rough turned axle stood 21 blows of a 1640-pound drop from 43 feet height, and the smooth forged one stood 78 blows, or almost four times as severe a test.

Tensile tests cut from the broken axles showed the same chemical and physical structure.

Extensive tests made at another works by one of the leading railroads specifying this, show that in axles of the average carbon, the smooth forged axle will stand approximately 43 per cent harder test than the rough turned one. Rough turning an axle also makes it more susceptible to rust.

These are but a few tests, of many made along this line, the aggre-

gate of which leads us to believe that the railroads of this country are annually expending hundreds of thousands of dollars on this feature, and are thereby getting an inferior axle.

BROKEN AXLES.

C—"What we have found as a result of the examination of broken axles":

In fifteen years' experience in the manufacture of steel axles, the writer recollects of but seven of our car axles having failed in service, four of these being due to inferior design, the wheel fits sizes being ⅝ inch under the Master Car Builders' standard dimensions.

We believe this record is due, not so much to the superiority of the steel itself (although the company which I have the honor to represent is the pioneer steel company of America), but to the fact that it is the policy of our company to thoroughly anneal every forging produced, thereby eliminating all forging strains and results of imperfect heat treatment, and restoring to the steel its true strength.

Our experience with broken axles, therefore, is limited and perhaps other members of the club can give more information on this subject than the writer.

We have, however, seen broken axles around in various railroad shops, the examination of which leads us to the conclusion that failures were due to the fact that steel used was too low in elasticity and tensile strength, steel of probably .30 per cent or .35 per cent carbon being used.

The failures were due largely to what has been termed "fatigue of metal" and show a detail fracture, a gradual parting of the steel, extending inward towards the center of all around the piece, unquestionably caused by the imposed strains repeatedly approaching the low elastic strength of the soft steel.

The substitution of a steel of higher carbon and elasticity would prevent failure of this kind.

The observations of Dr. Chas. B. Dudley, the eminent chemist of the Pennsylvania Railroad Company, are interesting and pertinent to this subject, and we quote him: "It is obvious that the journal of a car axle gets alternating bending stresses—that is, the metal is subject to alternate tension and compression with each revolution and that during the life of an axle, these stresses are many thousand, perhaps million, times repeated."

Again, the metal between the wheels is in like manner subjected at each revolution to the same alternating stresses.

The effect of these repeated alternate bending stresses are almost too well known to need comment. Sooner or later, if the stress is high enough, all metal will rupture under these alternate strains.

A marked characteristic of the fractured surface of a piece of metal which has broken from this cause, is that it never presents fibrous appearance in the fracture, but is more or less smooth, possibly due to the

fractured parts rubbing against each other, and having the appearance of an old break. It commences where the maximum stress occurs on the surface of the section and gradually works in from the surface until so small a part of the original area is left unbroken that a sudden shock or stress finishes the rupture.

This breaking slowly, a little at a time, led to the description of this fracture as "detail fracture," which will never be confounded with a rupture produced in any other way.

The experience of the Pennsylvania Railroad Company on car axles on this point may be interesting: Steel axles were first used on the Pennsylvania Railroad in 1875. The maximum calculated fiber stress between wheels was about 15,000 pounds per square inch, and the maximum fiber stress in the journal was about 6,700 pounds per square inch. The steel of these axles was an acid, open-hearth steel, containing from .22 to .28 per cent carbon, and not over .04 per cent phosphorus, and with a tensile strength of about 65,000 pounds per square inch, and an elongation in two inches of over 25 per cent. So tough was this steel that one passenger car axle was tested under the drop test with 67 blows without rupture. Some 300 of these axles were put in service, and in the course of two years, the journals began to fail from detail fracture. The matter became serious, and a consultation was held as to how to meet the difficulty. There seemed but two ways of procedure—either to increase the size or to change the nature of the metal. Since an increase in size meant a re-design of all the parts, the latter alternative was chosen, and a metal of 80,000 pounds tensile strength was substituted for the softer steel, no other changes being made. This completely cured the difficulty, and no case of breaking in detail in car axles is known to have occurred since that time, unless the metal was of lower tensile strength than the figure given, or the axle was worn to limit, so that the maximum fiber stress was too high.

Endurance tests made at the Watertown Arsenal by the United States government on wrought iron and .45 per cent carbon steel bars 1 inch diameter, 36 inches long, loaded in the middle so that the fiber stress was 40,000 pounds per square inch, show a great superiority in favor of the latter.

These bars were rotated 1,500 times per minute, the number of revolutions being recorded.

The average number of revolutions of the wrought iron bar was 59,000, while the .45 per cent carbon steel bars broke after 976,000 revolutions, or 16.5 times as severe a test.

To test the value of iron or steel for axles, and the effect of strains similar to those imposed by service, Mr. Wohler, chief engineer of the Prussian State Railway, constructed machines for the purpose, by which the bars were exposed to vibrating actions and repeated strains within adjustable limits.

First. For straining a cylindrical bar in a manner similar to that in

which an axle is acted upon by the load it carries: A bar, placed in bearings, was caused to revolve; to one end (corresponding to journal of axle) was attached a spring, giving a constant downward pull, by which action the bar was bent down at the end to a fixed distance, and, in its rotation, the action of the spring caused it to bend in all directions successively all around the circumference of the bar, by which means the alternate strains of compression and tension were produced. The breaking strains of fibrous iron, under these conditions, was from 20,160 pounds to 22,400 pounds per square inch; soft steel, 26,880 to 33,600 pounds per square inch.

Testing further, the effect of repeated strains applied to the center of a revolving axle, in which the fibers in each section are strained in the same direction each time, the tension on each fiber varying between zero and the strain imposed: Fibrous iron broke at a tensile strain of 33,600 to 40,320 pounds per square inch; soft steel at 50,400 to 56,000 pounds per square inch.

Walter E. Koch, formerly of the works of Landore (the original Siemans Works), and later of Pittsburg, in his paper on "Fifteen Years' Experience with Open-Hearth Steel," says: "Statistics show in Great Britain that eight iron axles break to every one of steel, and it is astonishing to me that so many iron axles are still in use in this progressive country." Mr. Koch, when written to concerning this statement, said: "I referred to straight and not to crank axles, and at that time there were about half iron and steel in use."

We could cite results of many such experiments made by many men under many different circumstances, but it was long ago demonstrated that too much statistical information is not wanted, the average man's aversion to such data being well expressed by Hon. C. D. Wright when he said, "Figures won't lie, but liars will figure."

We feel that the steel axle is now so well established that the many experienced gentlemen who are with us to-day can contribute information of a far greater value.

MR. REPLOGLE: I will say in the advance copy sent out there was a misprint, making the limit .40 to .50 per cent. I suggested .40 to .50. (Referring to paragraph 1, page 4.)

PRESIDENT CRAWFORD: Gentlemen, you have heard the paper; it is now open for discussion. Mr. Barnum, can we hear you start the discussion on this subject?

MR. M. K. BARNUM: Mr. President, it seems to me that Mr. Replogle has covered the subject from a general point of view very thoroughly and in a very competent manner, and has brought out some very interesting facts, and I think those who will attend the Master Car Builders' Convention ought to bear in mind his suggestions for changing the specifications, as he seems to have advanced good reasons for the same, and is in position to make suggestions which are expert and which would

improve the quality of axles made according to the revised specifications.

I have always thought that the use of steel for axles and crank pins was in line with progress generally, and that it was becoming more and more necessary to adopt steel for those purposes on account of the difficulty which has been described in this paper of obtaining a high grade of iron. While with a western railroad several years ago we paid as high as seven cents a pound to get the best quality of iron that could be obtained for driving axles, and even for that price were unable to get a sufficient number of axles which would meet our requirements and which were free from seams and showed a homogeneous nature, which would give a satisfactory journal when turned, and the result was that we had to throw out a large shipment of driving axles, some of which were nine inches in diameter, and had to make a settlement at a reduced price with the party furnishing them and use them for other purposes, so that we were practically driven to the use of steel on account of our inability to get iron of a satisfactory quality for the purpose.

The smoother journals obtained from the steel axles and the greater tensile strength, seem to me arguments in favor of the steel which are so very plain and forcible that they are hardly necessary of elaboration; they speak for themselves.

MR. A. E. MANCHESTER (C., M. & St. P. Ry.): Mr. President, I had hoped that some one that had a greater amount of experience with steel axles and was a better friend of the steel axle than I am would do the most of the discussing of this subject. I am pleased, however, to note the efforts that are being made by the steel manufacturers to overcome the defects that we find to exist in the axle, because of the fact that no doubt in time, due to inability to procure good iron cheap, the steel axle will be almost universally in use, whether it be a better axle than the iron or not.

There are a number of points raised in connection with the steel axle that do not correspond with my observations. The statement is made that the steel axle receives a higher polish, and consequently creates less friction. That has not been my experience; in fact, it is just the reverse, that the steel axle wears more rapidly, both the bearing and the axle, than does the iron. That polish taken by the steel is not the looking glass polish that is taken by a good iron axle.

The question has come up in my expirence as to what was a safe fiber strain for a driving axle, and I would like very much to have the writer give his opinion as to what would be the proper fiber strain for a driving axle.

PRESIDENT CRAWFORD: This is a very interesting paper, gentlemen, a very important one, and we would like to hear further discussion on it.

MR. H. A. FERGUSSON (J. T. Ryerson & Son): I should like to ask the author what is the effect on a journal which becomes very hot and is cooled with water on the road on an axle that has been annealed and

treated with the toughening process mentioned. Does it not change the character of the metal at the journal end and make it different from the body of the axle?

I notice, also, in the recommendation with regard to changing the specifications, that the recommendation was made to have the percentage of carbon increased from the present requirements .40 to .55, and that if this were the case it would necessitate a modification of the present drop test and also would permit of a higher polish with a consequent reduction of friction. The point that occurs to me is that the difference is only five per cent in the minimum, and five per cent in the maximum, leaving a common mean of ten per cent, that is, from .40 to .50, as at present, so that the maker has the right at present, in either specification, to a ten per cent mean between the two, and unless all the axles were furnished above .50 per cent carbon it would make no difference from the present specifications. I would like to know in this connection what proportion of axles are furnished below .40 now? If only a few I cannot see that the change would make much difference.

Then further, in connection with the higher carbon, the author says in regard to broken axles, "The substitution of a steel of higher carbon and elasticity would prevent failure of this kind," meaning breakage and refers to detail fractures as being caused evidently in this case by low carbon, and though that has been my experience, I have also always understood that an increase in carbon made an axle more liable to detail fracture from constant blows.

And then further on, on the last page, he mentions the specifications for the first Pennsylvania Railroad steel axles, stating that they contained from .22 to .28 per cent carbon and that it became necessary either to change the size or to change the chemical composition of the metal; that the latter alternative was chosen and that they obtained the finest axles that never broke. Therefore, why is it necessary to change the carbon, to increase the carbon at present when it is already considerably above those figures?

PRESIDENT CRAWFORD: If there is no further discussion, we will ask Mr. Replogle to close the discussion and answer the questions that have been asked, and also any other questions that may be asked.

MR. REPLOGLE: Mr. Manchester says that it has been his experience that an iron axle is capable of a higher polish than one of steel. We believe this to be the case when comparing an iron axle wth a low carbon steel axle, but with a higher carbon steel, above, say, .40 per cent carbon, we do not think it is the case; we think it is capable of a much higher polish and much less friction than the best iron axle that he can get.

In regard to the question as to what would be safe fiber strain for a driving axle, that is an engineering problem which we think should be worked out by engineers from results obtained in service. We would say, though, that if we were figuring on that, we would figure on about

17,000 pounds to the square inch. It is the practice of the Pennsylvania Railroad, I believe, to figure some of their forgings, crank pins, etc., at 14,000 pounds. Probably our President could inform us as to that, but on axles I think they figure even a trifle lower than that, but I do not think it would be safe to figure above 17,000 pounds to the square inch.

Mr. Fergusson asked in regard to the effect on the journals of axles which had been treated by toughening process becoming hot and being cooled by water. We would say that if the journal was heated to the critical temperature—which in steel of .40 of one per cent carbon would be about 1,200 degrees, and which is the changing point of the metal where it changes from the non-hardening to the hardening state, it would be injurious, there is no question about that. But, however, if uniformly heated again after such treatment, it would put it on a par with other axles that are untoughened, probably some better, as it would have the advantage of annealing. We think it is very seldom, however, that axles in service are heated to that temperature.

As to drop test modification suggested in our recommendation of increase in carbon, we would say that we do not think an axle in service is subjected to any such a test as is given under the drop test. However, as far as our company is concerned, we would very readily waive that. We do not have any objection to your making the requirements more severe, because it will result in our competitors taking steps to thoroughly anneal their axles or it would be impossible for them to compete with us.

We are at a great disadvantage now in that very thing. We spend about $50,000 a year in annealing and toughening our axles, something which no other manufacturer does, and in these days when the buying is entirely in the hands of purchasing agents, the majority of whom do not care to discuss anything but price, we are very often at a great disadvantage in that way, and personally, I will confess that I have at times favored the elimination of annealing, not because I do not think it is the proper thing, but from a purely commercial standpoint. The management of our company, however, would never consider such a proposition, but maintain that the railroad man will recognize that there is no economy in buying material which is unfit for this severe service, even though he can get it at a slightly reduced price.

There are a great many mechanical people today who specify and who thereby get the very best material, and others who do not specify, leave it entirely in the hands of purchasing agents, who are naturally going to get the cheapest material obtainable, and the result is unsatisfactory service, for which the mechanical man is responsible.

About the carbon of axles, at present it is natural for the steel manufacturer to get just as close as he can to the minimum limit on carbon to avoid chances of failure under the drop test. I would say that our company last year had but two failures of car axles under the

drop test. This we confess is a better record than we usually have, and as we say in the paper, it is entirely due to the elimination of its intrinsic strength. If you place the minimum carbon limit to .40 per cent it is not necessary for the manufacturer to put in .55 of one per cent carbon, but in actual practice it is hard to govern the required limit to within, say, about 10 points; you will find very often it will go over .50 of carbon in the annealed axle you get, so it is perfectly safe to increase your hardness to that extent.

As to the alternating strains on steel, I will say that an experience of ours demonstrates that the higher the carbon the less liable the axle or forging is to break from any detail fracture. In steam hammer piston rods, used for hammering car axles, we used it years ago and we had failures very frequently, often once every five or six weeks; we then started to use steel and our trouble ceased to a certain extent. We replaced the rods every two or three months, I should say; we put in a higher carbon steel, the grade we at present use, running about 90,000 to 95,000 tensile strength, elongation about 25 per cent in two inches, and since using that we have only broken one piston rod in three years, and the superintendent of our mechanical department says that we save at least $4,000 per year in that way.

As to the experience of the Pennsylvania Railroad, I would state their carbons have been fixed the same as the Master Car Builders, viz., .35 to .50 per cent.

Since adopting these limits Dr. Dudley states that no fractures "in detail" have occurred. He does not say that they have had no failures, but these have been greatly reduced, and could be still further minimized by a slight increase in carbon, which would also insure better wear.

MR. BARNUM: I would like to ask the author of this paper exactly what he refers to under the expression "if properly treated," under his first suggestion for changes in the specifications. I do not clearly understand that point.

MR. REPLOGLE: I refer to annealing and proper hammering. I have been around quite a little this last year among the various railroad shops, and have seen axles being forged under hammers of not more than 2,000 pounds falling weight; there was not sufficient power to penetrate the metal, the result is, very often, "piped steel." The effect of the hammering would be only on the surface, probably only an inch and a half in from the surface, with results as before stated.

Annealing destroys the internal strains due to forging under quite different temperatures. Many axle makers today, even, put one end of the axle in the furnace, heat it up to a stated temperature and forge it, then put the opposite end in the furnace and forge that, with probably 200 or 300 degrees difference in the heat. We feel that the true strength of the steel is not represented, and by the elimination of these irregularities by annealing all troubles of that kind would cease.

THE SECRETARY: Mr. President, before we go to the discussion of the next paper, I would like to say that the funeral of Mr. Barr will be tomorrow afternoon at 2:30 o'clock at Libertyville. A special train will leave the Chicago, Milwaukee & St. Paul station at 1 o'clock; this train will take any of the members who wish to go to the funeral, free of charge.

PRESIDENT CRAWFORD: The next paper will be, "The Electric Headlight as a Safety Appliance," by Mr. J. A. Carney, M. M. C., B. & Q. Ry.

THE ELECTRIC HEADLIGHT AS A SAFETY APPLIANCE.

By Mr. J. A. Carney, M. M., C. B. & Q. Ry., West Burlington, Ia.

The electric headlight as an adjunct to modern railroad practice has a great many advantages and some deficiencies. As a warning to the public who may have occasion to cross the right of way at grade, its value is almost without estimate.

Some years ago a railroad running through a prairie state put on a high speed train leaving a terminal about 9:30 p. m. Electric headlights were not used at the time of its installation and there were a number of highway crossing accidents. The engines running the trains were afterwards equipped with electric headlights and the crossing accidents stopped.

A man approaching a railway crossing and hearing the whistle would say to himself, "Freight, plenty of time," and get on the track about the same time the engine reached the crossing. The electric headlight is a warning to the public that a high speed train is approaching and they exercise more care.

The accident report of the Interstate Commerce Commission gives no data on highway crossing accidents, whether or not the engine involved was equipped with an electric headlight, but nevertheless high speed trains equipped with electric headlights are remarkably free from crossing accidents after dark.

An electric headlight burning in a switching yard is a nuisance, and it almost obliterates hand lanterns and switch lights that come in its field, and at many division points it is the rule to shut down the light while the engine is waiting for its train.

The diseases of the electric headlight are many. It is the purpose of this paper, however, to touch on one only, namely, the effect of the diverging rays of light on the vision of the engine man during snow, rain or mist, so far as being able to see signals at a safe distance. Heavy snow and rain do render signal lights invisible, except at short distances, and it is needless to describe the effect of fog, but where these elements are of such quantity that they do not obscure signals at safe distances is where the electric headlight does the most harm. The diverging rays light up the particles of rain and snow or mist and produce a curtain of light which it is almost impossible to see through. The effect is a parallel of the optical illusion produced by a stage lined with black and the outer edges brilliantly lighted. Nothing can be seen back of the lights and many clever tricks are exhibited and the audience remain in ignorance of the mechanisms used in producing the illusion. Not that the electric headlight is a trick or an illusion, but under certain conditions of fog, snow or rain it may render signals invisible.

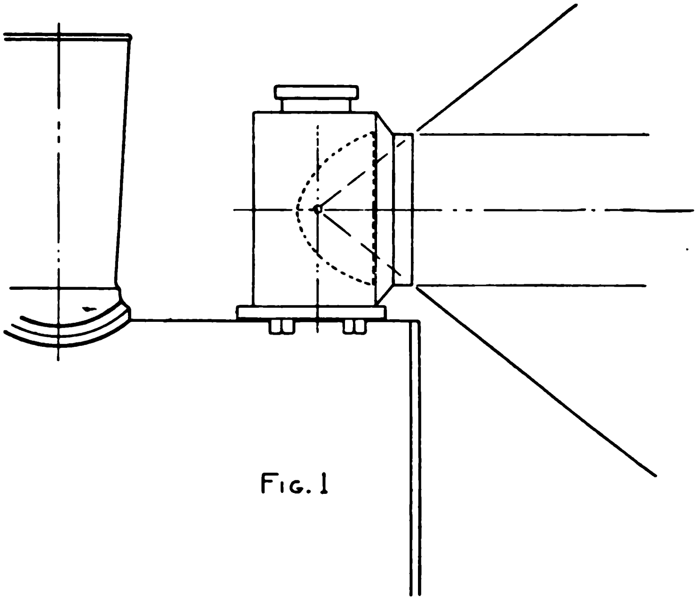

FIG. 1

Figure I is drawn from dimensions of a well known make of electric headlight, the parallel lines in front represent the parallel rays of light reflected from the parabolic reflector and amount to almost 70 per cent of the light produced by the arc. The diverging lines represent the light rays coming from the front of and directly from the arc and amount to

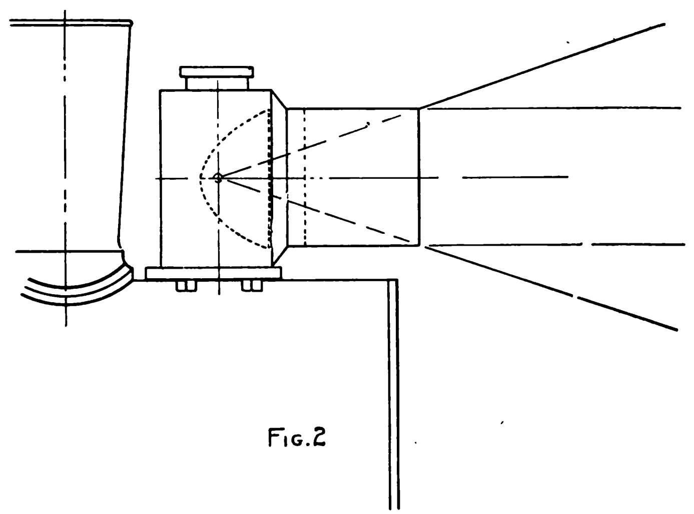

FIG. 2

almost 22 per cent of the light produced; about two-thirds of the direct light is of little benefit in good weather conditions and positively harmful in rain, snow or mist.

Figure II represents the same headlight with a circular extension to the case 15 inches long. The parallel and diverging rays are represented as in Figure I. The extension cuts down the angle of the direct rays from 78 degrees to 40 degrees. It does not in any way interfere with the reflected light and only about one-third of the direct rays are open to objection.

The headlight as described in Figure II is in service and gives a sharper pencil of light and seems to illuminate the track better than does the standard case. See Fig. I. Since this form of case has been in service there has been no opportunity to test its merits in mist or snow but observations made in a light rain storm testify in its favor.

Experiments on both forms of cases were made with circular stops, having ten and twelve inch openings. The results were not entirely satisfactory and while they cut out the diverging rays, they diminished the volume of light thrown ahead to an objectionable extent.

As a warning to persons on the track there is no difference in the effectiveness of the two forms of cases, and at a distance of half a mile it is impossible to tell one from the other by the volume of light thrown out.

The transparent number plates were placed in the extension and their illumination is perfect.

There is room for improvement in electric headlights along the lines described in this paper.

MR. CARNEY: The idea was first suggested by Dr. H. B. Young, of Burlington, who is making a study of the required vision of engineers, and in connection with his studies he did considerable riding on engines on the C., B. & Q. railroad at night, both behind an electric headlight and behind an ordinary oil light, and he observed the condition of the curtain of light which we find in a snow storm. I do not think he did any riding through fog. This led to the experiments which have been partially described in the paper.

I tried, before writing the paper, to get some information with reference to searchlights, but was unable at the time to get anything definite. This morning I looked up the question, and I found that searchlights have the carbons set horizontally, so that the whole of the light is thrown on the reflector. The electric headlights have the carbons set vertically, so that a portion of the light is reflected and a portion is thrown ahead.

I believe it is possible for great improvement to be made in the illuminating effects of electric headlights. Their value is unquestionable from a great many standpoints, but the diverging rays, as described in the paper, are a nuisance, and at times they may be dangerous.

PRESIDENT CRAWFORD: You have heard the paper, gentlemen; it is now ready for discussion.

MR. BARNUM: I would like to hear what Mr. Ross has to offer on the suggestions made by Mr. Carney. Mr. Ross has made this subject a study, and I believe he should be in a position to criticise Mr. Carney's paper, and give us some ideas worth listening to.

MR. MARK A. ROSS (Pyle National Electric Headlight Co.): I hardly think that I can criticize Mr. Carney's paper very much, except that my experience has not been as he represents it in the formula, and the exception I would take to the paper, you might call it an exception or criticism, is his saying that the electric headlight under certain conditions of fog, snow or rain may render signals invisible.

It has never been my experience that the electric headlight would render signals invisible under any conditions, but any signal is invisible in a fog, I do not care whether you have an oil headlight, no headlight or electric headlight, and I know that some manufacturers of a certain headlight claim that they can penetrate a fog.

My idea of a fog is that it is made of particles of water which reflect light, and I do not believe that the particles of water care whether it is gas, electric or oil, providing the light is strong enough to be reflected. I have ridden on locomotives in a fog; in fact, I was on a locomotive with an oil headlight when the conditions were practically the same as holding up a white sheet in front of the engine; you could not see the classification light on the front of the engine. I have seen a condition of that kind with oil; I have also seen the same condition with the electric headlight, and I do not see any difference. I do not believe you can see a light or a signal under any of those conditions.

As I understand his last remarks in regard to Dr. Young, his experiments are for the purpose of testing the effect of the light on the eyes. I am sure I do not know what the result of that would be, but I have given about eight years of my time, the principal part or share of that time in looking into the arcs, have very closely studied the arcs, and I do not believe any man has a better pair of eyes than I have. I have a great many letters in my office, too, from engineers who are running the electric headlights who state that they strained their eyes more in running an engine with an oil headlight in one night than they ever have with the electric headlight, for the reason that they are always gazing fixedly ahead, trying to find or pick up something, while with the electric headlight they can sit back in the cab, do not have to put their head outside of the cab to see anything, just the same as they can in the daytime.

I rode on a locomotive on a very fast train about a year ago, perhaps longer, in a very heavy snow storm. The snow was so damp and heavy that the engineer had to open the front window or front door very often to push the snow off the glass—it adhered to the glass and banked up in front—and I suppose that 75 per cent of the time we had

a hole no bigger than two inches in diameter to peek through, and I say it was one of the prettiest sights I ever saw, and we had a plain view of the track and could see anything that we wanted to see.

In fact, to cover the whole case, I have never seen such conditions that you could not see as well with the electric headlight as you could with any other light.

I might say here that several years ago we had a great many criticisms to the effect that the electric headlight destroyed the color signals. In fact, a prominent mechanical official read a paper before the New York Club several years ago, in which he said in effect that the strong ray of light from the electric headlight thrown on the lens of the switch lamp reflected and destroyed the color of the light. We immediately got an engine on the Big Four Railroad and had newspaper representatives with us; we took switch lights and hand lanterns and semaphore lights of all kinds, and we failed to find in our tests of all kinds and conditions that we could think of any case where the color of the light was destroyed, and the consensus of opinion was that the colors were intensified, if anything. Quite recently I was talking to this gentleman who brought up the subject himself, and said that he at one time, standing at a station, saw an electric headlight which was coming along, shining on a switch light, which a minute before was red, and it was white. But he said since then he had tried a great many times to find the same condition and he could not find it, and he had come to the conclusion that he was mistaken. He said he was thoroughly convinced now that the electric headlight does not destroy signals, and of recent years we do not find that criticism, or very little of it.

MR. G. L. WILSON (F. Cortez Wilson & Co.): Regarding headlights, I have had a little experience with them, covered about fifteen thousand miles of road on engines one year to find out something about them, and have developed a number of applications of light to locomotive headlights.

The trouble which Mr. Carney describes, judging from my observations and the developments which have resulted from my own work, I believe is more largely psychological than physiological. We all know how difficult it is, when there is anything like a noisy man working at the ventilators, for instance, for us to concentrate our attention upon the matter in hand, and observation leads me to believe that the main difficulty in connection with scattered light with the average man in charge of an engine is the fact that in his immediate vicinity objects are lighted up, instead of all his light being concentrated on the right of way ahead.

A somewhat similar condition obtains when a cab is not sufficiently darkened; there is something more than the reflection of the light on the inside of the cab window to divert attention. All those who have been on engines at night know that if the cab lights are not well masked, the headlight is nearly killed. So, in this case, the difficulty which Mr. Carney finds with the electric headlight is traceable directly

to the intensity of the main source of light, since the relative power of the direct rays from that light cause a masked illumination of the immediate vicinity of the engine.

My criticism of his fifteen-inch extension would be that under all ordinary conditions, that is, on a relatively clear night, there would be too much darkening immediately in front of the pilot of the locomotive, which does not cut any particular figure on the road, at terminals or large stations where the yards are adequately lighted, but at the ordinary stops made by an engine in this country it is a source of actual danger if an engineer cannot see what is right up close in front of the engine, and there have been some apparently very stupid accidents for which the enginemen were in no wise responsible, when they have run down people just as their trains were starting, because of this darkness immediately in front of the engine. There is a point here on which we must reach an average. Investigation of the subject leads me to believe with him that it is desirable to extend a casing somewhat beyond the front line of a parabolic reflector and by that means cut off the direct rays. This must not be overdone or else you defeat one of the greatest safeguards attending the use of a high power light.

The light with which I have worked is acetylene, and while it has not the range of the electric light, when properly applied to parabolic reflectors, acetylene will furnish a light which penetrates far enough for an engine man who is keeping his lookout to find all ordinary obstructions on the track and slow down so that his train is safe. At the same time you have an initial source of light approximating 50 candle power, which gives the little halo in front, not enough to distract attention, but bright enough to show the careless person who runs in front of a locomotive about the time it is to start and enable the engine man to keep the train under control until such time as this person is out of the way.

In regard to seeing these headlights on approaching engines, I know, because I have heard many superintendents of motive power and other operating men say so, that the average man who is thrown in contact with railroad operation regards a headlight as little more than notice to the public that a train is coming. Many of them are outspoken in that belief, and those of us who have heard anything about the operation of trains in other countries are convinced that in England, at least, that is all the light is used for. They have a light on the front end, but do not try to light the track, and use nothing more than a bulls-eye. The feeling in this country is more widespread than we are willing to admit that this is the sole function of the headlight. But it is not.

Consider an engine man on a mountain road where rocks are likely to come down on the right of way as well as trees and various other things. Consider a man operating anywhere in an open prairie country where cattle are likely to be on the track, anywhere where roads are not fenced pig-tight and crossings always above or below grade; consider those places where cars on sidings may obstruct the main line; the

engineer who has had any experience with high-power lights knows that the light which shows in his track for a reasonable distance ahead is a factor of safety, and for that reason roads today are turning to electric or acetylene headlights.

Regarding the actual question of the reflection of light from particles of snow in the atmosphere, from rain and so forth, it is certain that the ordinary heavy rains do not make any particular difference with the vision of a man behind the light, if the light is good. A thick snow is hard to see through, no matter what light you have, and a bank of fog is pretty nearly impenetrable if it is thick enough; but, as Mr. Ross says, while it may not make any difference to the particles of water and the fog, it does make a difference to the man behind the light, and there are some lights that have a greater diffusible quality than others.

I do not know why we have become accustomed to measure lights in candle power, since there is another quality to be considered. There is an unrecognized but marked analogy between sound and light. Motive power men who have paid any attention to bells and whistles for engines know that pitch and quality have quite as much effect upon the value of such appliances for signal purposes as does the mere volume of sound—perhaps more, if we are to accept some data which appear to have a scientific basis. The modulation, pitch, clearness and timber of the human voice are recognized everywhere as greater influences in reaching the auditor than mere volume of sound. It is not "candle power" which determines the power of light, nothing but its capacity to diffuse light over things in proper shape to reflect back to the retina. Some day somebody will find some way to measure it. I have not solved the question, I have not had time, but it is there.

I would suggest that experiments be continued with a view to cutting off the direct rays in the halo of light in front; there is plenty of light in your electric headlight. Perhaps if Mr. Carney will put a disc in front of the arc it will not interfere seriously with the reflected light, which does the business on the track, and it will cut off all those diffused rays which cause the trouble. This will reduce the scattered direct rays from the arc light and make it approximate those ideal conditions which obtain when the acetylene flame is used in properly designed reflectors and headlight casings, especially arranged to utilize it to the greatest advantages for all the purposes which a locomotive headlight should serve.

MR. ROSS: There is a variety of opinion as to what a headlight should be. For instance, if you put a hood or an extension on your headlight, you can confine the rays to a certain extent, on the same principle as a searchlight. You take a deep reflector and you get more penetrating power, but you do not cover a large enough space. Your light half a mile or three-quarters of a mile ahead of the engine will only light up the size of half the track, perhaps, or just the track, and it has not been my experience that that is best. For that reason we use a parabolic

reflector, which will, to a certain extent, separate the rays, or give a larger pencil of light, as we call it. That will give you a full view of the track a great distance ahead. On that line of thought, I think perhaps the extension would be a good thing in the majority of cases, but there are cases where engineers on fast trains going into large terminals or large yards want to see immediately in front of the engine; there are very short curves in some places, and they want the light nearer the engine. In that case I think it would be an objection, but I think there is no doubt but that the contrast between the dark and light would be more noticeable than it would be without the extension. In putting a disc in front of the headlight, we have had some little experience in that direction, and we found that the rays would be conflicting with the direct rays, which will always interfere with the penetrating quality.

MR. E. J. SAXE (Engineer, C. B. & Q. Ry.): It seems to me there is one feature of Mr. Carney's paper deserving of more attention than has been given it, and that is the desirability of lighting up the number plate. I think most of us have felt that the engineer is lighting up more of the corn field than is absolutely essential, but I think a great deal of the power of a reflector is sacrificed to light up the number plates on the side of the lantern. Perhaps Mr. Carney can give us some information on this subject. It does seem to me that that projecting hood would be a good arrangement, if only to light up the number plates.

MR. BARNUM: This article is headed "The Electric Headlight as a Safety Appliance." If there is any one man more interested than another in safety appliances, it is the engineer at the head of the train. I have had experience with electric headlights on three railroads, and on all those roads I found the engineers were the men that were most strongly in favor of the electric headlight, or some light better than the ordinary oil light. The more the engineer becomes accustomed to the electric headlight the better he likes it.

On the road with which I was recently connected we had 260 electric headlights, and on a late order of passenger engines these had not been provided, and they were put into service with ordinary oil. Many of them were on fast passenger trains, and while it was the intention to transfer electric headlights from freight engines to the passenger engines in due time, this could not be done at once, and before it was done I received a number of personal requests from the engineers running these engines for electric headlights, as they claimed they were unable to make their running time with safety. Therefore, the fact that there are certain conditions under which the electric headlight may be handicapped does not, in my opinion, prove that it is not a very important safety appliance and one of the best of its kind.

MR. MANCHESTER: I agree with what has been said by Mr. Barnum. The enginemen look upon the headlight as a safety appliance; that it makes it easier for the man behind the electric headlight to run his train at a high rate of speed and with more confidence. The electric

headlight has its drawback, indeed, on a double-track road, it has its effect on the eyes of the approaching engineer, and for the time being, after meeting an electric headlight, it is difficult for him to discern signals correctly.

MR. ROSS: In regard to that subject I think you will find that experience goes a good ways in looking at the light, that it is something on the principle of looking into a firebox. When we were firing we could look into a firebox and it would not blind us, but we cannot do it now, and I think this experience applies in meeting a light on the road; instead of looking at the light, avoiding looking at it will overcome that objection to a great extent, and I do not think you will find engineers objecting to that very much where they have electric headlights and where they have used them for some time, or on double track. The Rock Island is double track between here and Rock Island, and I do not think I have ever heard that criticism there; same way on the C. & E. I. R. R.

MR. FERGUSSON: I know from experience that where a train without an electric headlight approaches one that is standing still on a single-track road on the side track, it is impossible to tell whether the train with the electric headlight is on the side or on the main track until it is very close. I have seen this time and time again where curtains were not used, and I also know that where the engine with the electric headlight is very near the semaphore it is almost impossible to see signals that the other train is approaching.

MR. ROSS: That was thoroughly gone into on the Rock Island and tests made on that particular point by all the superintendents on the entire system for two nights, and the tests were thoroughly satisfactory to all of them.

PREST. CRAWFORD: Mr. MacBain, do you use electric headlights on the Michigan Central?

MR. D. L. MACBAIN (M. C. Ry.): I have not had any experience, Mr. President.

DR. NELSON M. BLACK (Milwaukee, Wis.): I was present when Mr. Carney and Dr. Young made the experiment of adding an extension and cutting down the pencil of an electric headlight, and, personally, think it is a decided advantage in overcoming the difficulty it was intended for, i. e., lessening the interference with signal reading in bad weather conditions, such as fog, mist, rain and snow. These elements make it sufficiently difficult to observe signals without any other interference, and as visual recognition of any object is due to reflected or projected light from its surface, any refracting or reflecting substance between a definite object and the source of illumination will interfere with its being seen. The greater the source of light, the greater the disturbance (compare oil and electric headlights). The pencil of light from a signal lamp has a hard time penetrating the above-mentioned media in the atmosphere, but when in addition to this there is the reflected light from such an intense source neutralizing it, signal reading becomes difficult indeed.

The increased safety with the use of an electric headlight is real, not imaginary, although the feeling of security with good illumination is partly a psychological condition. Sensations brought to the brain by the eyes, which are the most highly specialized portion of the nervous system, are of more benefit than those from the other senses combined, and consequently anything interfering with this deprives the brain of some knowledge, and vice versa.

That one can see better with electric headlights is not to be questioned—it is a "self-evident truth." The divergent rays from the upper half of the circle, however, do interfere with the reading of signals in bad weather conditions, and I cannot see of what use these rays are. Reflect them down so that they cover the area directly in front of the engine, have the lateral rays as wide as you wish, but do away with the rays in the upper arc of the circle. In perfect atmospheric conditions there is no interference with signals that I could observe, but it is in bad weather conditions we most wish to see them.

As to the effect on the eyes of the approaching engine man, there will be a blinding produced if he looks into the light, but there is no necessity for that, and if the suggestions of Mr. Carney are carried out, this will be lessened. Mr. Carney's paper was given with the idea of increasing the efficiency of the electric headlight, not to depreciate its value.

The thought brought up by Mr. Ross that enginemen state that they strain their eyes more by the constant effort to see with a dim oil headlight is a good one, looking at it from an eye doctor's point of view.

It might be well to state that my conclusions have been arrived at from observations made from an engine cab, covering about 5,000 miles on various roads, in all sorts of weather and at all hours of day and night.

PREST. CRAWFORD: Any further discussion? If not, I will ask Mr. Carney to close the discussion.

MR. CARNEY: In reference to Mr. Ross' criticisms in regard to Dr. Young's tests on eyesight on engineers, these tests were not made with reference to electric headlights, but were made more with reference to determining how defective a man's vision might be at night without making him a dangerous man, so far as eyesight was concerned, and the observations made in snow with electric headlights were incidental and had no connection with any effect on the eyes whatever. So far as I know, the electric headlight has no effect on the engineer's eyes. With reference to the advisability of having the light well spread on the track and at the side of the engine, that may at times be an advantage if a train is running slow; but our experience has been that with high-speed trains, if a man gets close enough to the engine so that the light from the diverging rays shone on him, there was very little chance for that man to get off the track.

With reference to the illumination of number plates, that is a

subject that the C. B. & Q. Railroad has discussed and made a great many experiments, and I believe that the extension headlight case which I am experimenting with is the only one which has perfectly lighted the number plate. What the effect on the amount of light reflected from the electric headlight having holes in the sides of the reflectors has, I cannot say. So far as my observations go, it amounts to very little. Of course, theoretically, there is a loss of light, but the electric headlight is so powerful that even ten per cent of a loss would not be noticed.

With reference to Mr. Fergusson's criticism on electric headlights on the single track, I believe it is the rule on most roads to turn out the electric headlight or put a curtain over an oil light when a train is standing on a side track of a single-track road.

This paper was not written with the idea of criticising electric headlights, nor with any idea of showing that they were not a good safety appliance. The idea was to criticise the diverging rays. If the rays of light are thrown as in the searchlight, it enables the engineer to look along this column of light and see signals to a reasonable distance. Whereas, if the light is spreading out and the snow or rain or fog, whatever may be in the atmosphere is sufficiently great so that there is more illumination to the particles of snow than there is from the signal half a mile away, he will miss that signal until he gets close enough, so that the intensity of the signal is greater than the intensity of the light from the particles of snow.

The paper makes mention of the fact that the engineman may not be able to see signals at a safe distance. It says: "Heavy snow and rain do render signal lights invisible, except at short distances, and it is needless to describe the effect of fog," etc.; that is, I mean to say that the engineer cannot see the signals until within a short distance on account of this curtain of light that is being carried in front of the engine.

PREST. CRAWFORD: This is the date of the annual meeting and the election of officers for the ensuing year. Before proceeding to this election, we will listen to the reports of the Secretary, Treasurer, Chairman of the Board of Library Trustees. They are as follows:

REPORT OF SECRETARY.

TO THE PRESIDENT AND BOARD OF DIRECTORS:

With this meeting we close the twentieth year of our existence as a club. As has occurred in past years, some of our former members have resigned their membership in the club for various reasons, others have neglected the first requisite of faithful membership, viz., the payment of dues, and have been dropped (we hope only temporarily) from the membership list. Death has claimed an unusual quota. A great many new faces appear at our meeting—103 new members having been added during the year.

Owing to the fact that this has been an unusually busy year for railroad men, it has been rather difficult to procure papers from them for discussion, and had not our railway supply friends come forward valiantly we would have had a dearth of papers for discussion. Eight of the nineteen subjects discussed during the year were presented by our railway supply friends.

MEMBERSHIP.

Our membership is as follows:

Membership, April, 1903		1,108
Resigned	48	
Deaths	9	
Dropped for various reasons	71	
	—	128
		980
New members admitted during the year, including April, 1904	99	
Reinstated	4	
	—	103
		1,083

According to the records of the Secretary, the following deaths have been reported:

E. O. Dana, H. A. Callan, C. F. Geyer, E. Grafstrom, Pulaski Leeds, J. G. Riley, J. N. Barr, J. A. Hinson.

In accordance with our usual practice, a page will be set apart in our annual proceedings that their names may be inscribed thereon.

FINANCIAL.

From the Treasurer's books the details of receipts and expenses and the financial condition of the club are shown:

RECEIPTS.

Balance on hand May 19, 1903	$ 883.48
Receipts from all sources	5,173.09
Total	$6,056.57

EXPENSES.

Cost of binding annual proceedings	$ 314.65
Cost of advertisements	640.22
Library—	
Salary, librarian, 12 months	240.00
Insurance	10.90
Incidental expenses	71.92
Office expenses	88.69
Postage	273.37
Printing proceedings, adv. copies, etc	1,726.87

Purchase of other club proceedings	1,041.91	
Reporting proceedings	195.00	
Salary, Secretary, 10 months	250.00	
Expressage on annual proceedings	139.65	
		4,993.18
Balance in hands of Treasurer		$1,063.39

The club has the following bills receivable:

From advertising	$794.50	
From annual dues—$4.00	292.00	
From annual dues—$2.00	268.00	
From sale of proceedings	148.88	
		$1,303.38

The only indebtedness the club has are the bills approved by your Board of Directors at its meeting this morning, amounting to $286.43, being the expenses of the club for the month just closed.

Of the bills receivable, the items for advertising and sale of proceedings will be collected, but of the amount due from members on account of dues unpaid, probably one-third or more is uncollectible, and should be charged to profit and loss, so that the assets of the club can be estimated about as follows:

From advertising	$ 794.50
From sale of proceedings	148.88
From payment of dues, one-third off	375.00
Unappropriated balance	776.96
Total available balance	$2,095.34

An analysis of the cost of exchanging club proceedings shows the following result:

To purchase of other club proceedings	$1,041.91
By sale of our proceedings to other clubs	38.64
Balance against us	$1,003.27

The report of your library trustees will be made indicating increase in the number of books in the library and also its condition.

Respectfully submitted,

JOS. W. TAYLOR,
Secretary.

REPORT OF LIBRARY TRUSTEES.

The President and Board of Directors of the Western Railway Club.

Gentlemen: The Board of Trustees of the David L. Barnes Library of the Western Railway Club present herewith their eighth annual report.

Your library now contains about 1,200 volumes, covering the most complete files of current engineering publications in existence in the

west, in addition to which you have a large number of standard engineering works forming a library of which any club may well be proud.

During the past year twenty-two volumes of periodicals have been added to the files, bringing them up to date, and thirty-one volumes covering engineering subjects, have been presented by friends and members of the club, and in addition to this, sixteen volumes of engineering text books have been purchased on account of the allowance made by the club for the acquisition of new current literature.

The attendance during the past year has slightly increased over that of the preceding year, which we consider an encouraging feature, indicating an increase in the interest taken by the members of the club in their library, and we hope for a still further appreciation to be indicated in a still further increase in the use of the library facilities.

The steady increase in growth of your library has been quite a tax on the facilities of the Railroad Gazette Company for housing the library, but they have taken good care of your property and again express their willingness to care for it throughout the coming year, making such changes as may be necessary to accommodate the increase in size of the library. In acceptance of their offer and in appreciation of the courtesy of the Railroad Gazette Company in caring for the library, the club should take the necessary action.

Your Board of Trustees at this time has no suggestions to make other than to recommend the continuance of the present arrangement with the Railroad Gazette Company whereby the library is continued in their care at 1750 Monadnock Block, in charge of C. H. Fry, Librarian, for the coming year.

Your committee would further recommend the usual vote of thanks to appear in the minutes and proceedings of the club to the friends and members who have kindly made donations to the library. The Secretary having duly acknowledged, on behalf of the club, the receipt of these donations.

The accessions to the library during the past year are as follows: (See attached list.)

Respectfully submitted,

F. W. SARGENT,
GEO. ROYAL,
W. F. M. GOSS.

ACCESSIONS TO WESTERN RAILWAY CLUB LIBRARY SINCE MAY 11, 1903.

Secretary: John Crerar Library, Eighth Annual Report.

Railroad Gazette: "The Effect of Brakes upon Railway Trains," by Capt. Douglas Galton.

Railroad Gazette: "Steam Engine Indicator and Its Appliances," by Wm. Houghtaling.

Railroad Gazette: "Indicator Diagrams," by W. W. F. Pullen.

Railroad Gazette: "The Cornice Work Manual," by Sidney P. Johnston.

Railroad Gazette: "Jim Skeevers' Object Lesson on Railroading for Railroaders," by John A. Hill.

Railroad Gazette: "Results of Recent Practical Experience with Express Locomotive Engines," by Walter M. Smith, before the Institution of Mechanical Engineers in London, October 27, 1898.

Mr. Edward A. Moseley, Secretary: Sixteenth Annual Report of the Interstate Commerce Commission, 1902.

University of Texas: Bulletin No. 6; The Mining Laws of Texas and Tables of Magnetic Declination.

Mr. L. C. Fritch, Secretary: Bulletin No. 41; American Railway Engineering and Maintenance of Way Association.

Mr. L. C. Fritch, Secretary: Proceedings of the Fourth Annual Convention of the American Railway Engineering and Maintenance of Way Association, held at the Auditorium Hall, March 17, 18 and 19, 1903.

Mr. F. M. Nellis, Secretary: Proceedings of the Tenth Annual Convention of the Air Brake Association, held at Colorado Springs, April 28-30, 1903.

Mr. J. W. Taylor, Secretary: Proceedings of the American Railway Master Mechanics' Association, Vol. 36, 1903.

Mr. Edward A. Moseley, Secretary: Fifteenth Annual Report of the Interstate Commerce Commission, 1902.

Mr. J. W. Taylor, Secretary: Proceedings of the Master Car Builders' Association, Vol. 37, 1903.

Railroad Gazette: Mayor's Message, Twenty-Seventh Annual Report, Department Public Works, Chicago, 1902.

Secretary: Transactions of the American Society Mechanical Engineers, Vol. 24, 1903.

Baldwin Locomotive Works: Record of Recent Construction, Nos. 21-30 inclusive.

Baldwin Locomotive Works: Record of Recent Construction, Nos. 31-40.

Baldwin Locomotive Works: Record of Recent Construction, Nos. 41-45.

Baldwin Locomotive Works: "Narrow Gauge Locomotives."

Peerless Rubber Manufacturing Company: "Compressed Air and Its Applications," by Hiscox.

Railroad Gazette: "Lectures on Commerce," delivered before the University of Chicago.

Mr. John Havron, President: "Locomotives and Locomotive Building in America," by the Rogers Locomotive Works.

Baldwin Locomotive Works: Record of Recent Construction, No. 46.

Mr. W. O. Thompson, Secretary: Proceedings of the Eleventh Annual Convention of the Traveling Engineers' Association, held at Chicago, September 8, 9 and 11, 1902.

Mr. J. H. Warder, Secretary: One hundred and ten back numbers of the Western Railway Club Proceedings; 85 back numbers of New England Railroad Club Proceedings; 82 back numbers of Northwest Railway Club Proceedings, and 55 back numbers of Central Railway Club Proceedings.

Mr. E A. Simmons: "Universal Directory of Railway Officials," for 1903.

Mr. W. H. Boardman: "Car Builders' Dictionary," 1903.

Mr. Edward A. Moseley, Secretary: Seventeenth Annual Report of the Interstate Commerce Commission, 1903.

Mr. Wm. Kilpatrick, Secretary: Thirty-third Annual Report of the Railroad and Warehouse Commission.

The following is a list of the volumes bound for 1903:

Electrical World and Engineer.
Street Railway Journal.
Street Railway Review.
The Engineer (Cleveland).
Railway Age.
Locomotive Engineering.
Engineering and Mining Journal.
Engineering (London).
Railway and Engineering Review.
Engineering News.
Railway Engineer (London).
Iron Age.
American Machinist.
Stevens Institute Indicator.
Journal of Associated Engineering Societies.
Journal of Western Society of Engineers.
The Engineer (London).
Railroad Gazette.
Sibley Journal.
Wisconsin Engineer.
St. Louis Railway Club.
Engineering Magazine.

The following is a list of books purchased:

Practical Physics of the Modern Steam Boiler.
Locomotives: Simple, Compound and Electric.
British Locomotives.
Locomotive Breakdowns and Their Remedies.
The Prevention of Smoke.
The Calorific Power of Fuels.
The Gas Engine.
Gas Engine Handbook.
Liquid Fuel and Its Combustion.
Electric Power Transmission.

Air Brake Catechism.

Mechanical Engineer's Handbook.

American Railway Transportation.

Electrical Machinery, Vol. 1.

Ganzenbach Engineering; Preliminaries for an Interurban Electric Railway.

Electric Street Railways, by Houston & Kennelly.

Thirty-one volumes presented; 22 volumes bound; 16 volumes purchased, $40.28; total volumes, 69.

TREASURER'S REPORT.

To the President and Board of Directors of the Western Railway Club:

Gentlemen: Herewith I hand you my annual report for the year ending May 17, 1904.

On hand last report	$883.48	
Received from Secretary July, 1903	887.50	
Received from Secretary August, 1903	419.50	
Received from Secretary September, 1903	281.00	
Received from Secretary October, 1903	232.00	
Received from Secretary November, 1903	739.00	
Received from Secretary December, 1903	514.45	
Received from Secretary January, 1904	447.25	
Received from Secretary February, 1904	380.39	
Received from Secretary March, 1904	526.25	
Received from Secretary May, 1904	274.50	$6,056.57
Paid out May 1903	$308.53	
Paid out July, 1903	380.68	
Paid out August, 1903	390.71	
Paid out September, 1903	638.46	
Paid out October, 1903	473.72	
Paid out November, 1903	482.59	
Paid out December, 1903	401.72	
Paid out January, 1904	531.55	
Paid out February, 1904	445.56	
Paid out March, 1904	438.42	
Paid out April, 1904	501.74	
Total paid out		$4,993.18
Balance on hand		$1,063.39

PETER H. PECK,
Treasurer.

On motion of Mr. Peck, the reports of the Secretary and Treasurer were referred to an auditing committee and the report of the Trustees of the Library was accepted and placed on file.

MR. F. W. SARGENT (Sargent Company) Is it in order to discuss the reports? If so, I would like to call the attention of the members of the Club to the fact that we are paying out over $1,000 a year for the proceedings of other clubs for a small portion of our members, and we are receiving only about $38 for the sale of our proceedings. This does not seem to be right, and inasmuch as all the other railroad clubs have done away with furnishing proceedings other than their own to the members without special charge being made therefor, I would move you that the Club dispense with the furnishing of these proceedings of other clubs to the members. That the members who in the past have been receiving those proceedings may make such arrangements as they prefer with the various clubs to get their proceedings, and that the $1,000 per year that will be saved by the change may be appropriated for a fund for the maintenance and enlargement of the Western Railway Club library.

Seconded.

PREST. CRAWFORD: It has been moved and seconded that the practice of purchasing for free distribution to the members of the Western Railway Club the proceedings of the other clubs be discontinued, appropriation be made for the benefit of the library of the Club. We will be glad to have any discussion on this motion.

MR. SARGENT: Before that motion is put, I want to say that we do not mean that the proceedings of the other clubs will not be on file in the library and the files maintained so that they will be accessible to any member of the Club at any time. They will have the proceedings of the foreign clubs in the library where they belong.

MR. BARNUM: Mr. President, in the meeting of the Board of Directors this morning, it developed that there were only about 240 out of 1,063 members who were getting these exchange proceedings, and quite a number of these 240 members are also getting the same by membership in other clubs, and furthermore, additional members are getting the gist of those reports in the technical papers, and it seems that the Western Railway Club is paying a very high price for a very small benefit to a small percentage of its members; that the money so expended can be used to a greater benefit for the Club and its membership. There are several ways in which this can be done. One suggestion was that we obtain—which is very badly needed—better quarters for the library, so that we can have a meeting place or headquarters for the Club, something more commodious and more convenient for the general use of the club members than the present quarters, which are always open, but which are limited in their space, and that is the reason why this question comes up at this time, and I believe that the Club, as a whole, would be very much benefited by this move.

MR. R. D. SMITH (C. B. & Q.): This is a matter that has been con-

sidered by several Boards of Directors, of which I had the honor to be a member, and it was never thought a wise thing to do before. Personally, I have always been in favor of the motion as made here today, but I would like to know whether this comes as a recommendation from the Board of Directors. If it does, I will feel more like supporting it than if it is just something brought up here personally.

MR. PECK: It does come as a recommendation of the Board of Directors. They voted on that this morning. Previous to this, for many years, the last board has always postponed that for a new board. We now think that it is wise to dispense with furnishing the proceedings, as we can use the money to better advantage for our library.

THE SECRETARY: I might say that the board at its meeting this morning, as Mr. Peck has said, thought that it would be a good thing to do to discontinue the purchase of other club proceedings and that this discontinuance should commence after the May issue of the other clubs. That will finish up the fiscal year of the other clubs' proceedings.

Motion was put to vote and carried.

THE SECRETARY: Mr. President, before we proceed to the election of officers, I wish to state that at the board meeting this morning, the death of Mr. J. N. Barr was reported. Mr. Barr was a Past President of the Club, was one of the oldest and most active members of the Club, and it was suggested that the President, with the assistance of such other members of the Club as he may call on, draft a set of resolutions to appear in the proceedings of this meeting, and I would like to suggest that as a motion, that the President be authorized to prepare a suitable resolution to be incorporated in the proceedings of this meeting on the death of Mr. Barr.

Motion carried.

Jacob N. Barr

Mr. Jacob N. Barr died at Libertyville, Ill., May 15, 1904, at the age of fifty-five years, after a life devoted to railway work in the mechanical and operating departments. He became a member of the Western Railway Club in September, 1886, two years after its organization, and was President during the years 1890-91. He was always an active participant in the affairs of the Club. The papers he presented and the prominent part he took in our discussions added not a little to the value of our proceedings in mechanical matters. Physically and mentally Mr. Barr was a large man: of fine intellectual attainments: possessed of a thorough, practical and theoretical mechanical training, and with a mind clear and acute, he was well equipped for the successful career which he achieved. By his death the Club sustains a severe loss, but it is to his family that our sympathies should extend in this hour of affliction.

A motion was made by Mr. R. D. Smith and carried that a vote of thanks be extended to the Railroad Gazette for housing the library during the past year and for their offer to take care of it the coming year.

THE SECRETARY: Mr. President, the next order of business being the election of officers, before proceeding, I will read from the constitution in regard to the election, so that you may know how it should be carried on under the constitution. The Secretary read that clause of the constitution applying to the election of officers.

I will suggest, Mr. Chairman, that we first have two collecting tellers and two counting tellers appointed.

The President appointed the following: Messrs. E. A. Gilbert and O. M. Stimson, counting tellers; Messrs. C. H. Fry, Jr., and George Isbester, collecting tellers.

The informal ballot for President resulted as follows:

Le Grand Parish, 40; J. A. Carney, 4; C. W. Cross, 1; C. A. Seley, 1; total, 46.

On motion of Mr. Peck, the vote of the Club was made unanimous for Mr. Parish.

The informal ballot for First Vice-president resulted as follows: J. A. Carney, 43; A. L. Sanger, 1.

On motion of Mr. Peck, the vote of the Club was made unanimous for Mr. Carney.

The informal ballot for Second Vice-president was: H. T. Bentley, 36; P. H. Peck, 1; C. B. Young, 6; M. K. Barnum, 2; C. W. Cross, 1.

On motion of Mr. Peck, the Secretary was instructed to cast the ballot for Mr. Bentley.

The informal ballot for Treasurer was: 41 votes for Mr. P. H. Peck.

On motion of Mr. Gilbert, the Secretary was instructed to cast the ballot for Mr. Peck.

The informal ballot for three members of the Board of Directors resulted as follows: M. K. Barnum, 27; C. A. Seley, 26; C. B. Young, 30; A. L. Humphrey, 6; William Forsyth, 3; F. W. Sargent, 2; P. Maher, 1.

On motion of Mr. Peck, the secretary, was instructed to cast the ballot for the three highest.

The ballot for Library Trustees resulted as follows: C. A. Seley, 32; F. W. Sargent, 29; Prof. Wm. F. M. Goss, 28; W. K. Barnum, 2; C. B. Young, 2; Lewis, 1.

On motion of Mr. Peck, the Secretary was instructed to cast the ballot for the three receiving the highest number of votes.

It was moved by Mr. Barnum that the Club extend a vote of thanks to the President for his services during the past year.

Motion was put to vote by the Secretary and carried.

MR. CRAWFORD: Gentlemen, I am sure I am very much obliged to you. I regret very much that I was transferred out of the territory of the Western Railway Club so that I did not have an opportunity to

be with you more frequently, attend more of the meetings than I have. I again thank you.

I will appoint Mr. Gilbert a committee of one to escort the newly-elected President to the chair.

Gentlemen of the Western Railway Club, I wish to introduce Mr. Parish, the President-elect.

PREST. PARISH: Gentlemen, I wish to thank you for the honor you have conferred upon me and I will do the best possible to foward the interests of this Club at all times.

THE SECRETARY: I would like to make the announcement that the following officers have been elected: President, Le Grand Parish; First Vice-president, J. A. Carney; Second Vice-president, H. T. Bentley; Treasurer, P. H. Peck; Directors, W. K. Barnum, C. A. Seley, C. B. Young; Trustees of the Library, C. A. Seley, F. W. Sargent, Prof. W. M. F. Goss.

I would also move that a vote of thanks be extended to the counting and collecting tellers for their arduous services and that they be discharged.

Seconded and carried.

It was moved by Mr. Peck that the Club send a floral emblem to the home of Mr. Barr in the name of the Club.

An amendment was made and accepted that a committee of three be appointed to attend the funeral.

PREST. PARISH: Gentlemen, you have heard the motion, which is that a committee of three be appointed to attend the funeral of Mr. Barr as representatives of the Club and that they take with them a floral emblem on behalf of the Club.

Motion carried.

The President appointed as such committee Messrs. A. E. Manchester, M. K. Barnum and P. H. Peck.

PREST. PARISH: I wish to say that there will be a meeting of the Board of Directors immediately after the Club meeting adjourns. There being no further business, a motion to adjourn will be in order.

Adjourned.

The Dead

E. O. Dana

H. A. Callan

C. F. Geyer

E. Grafstrom

Pulaski Leeds

J. G. Riley

J. N. Barr

J. A. Hinson

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OFFICIAL PROCEEDINGS

Western Railway Club

Vol. 16 May 17, 1904 No. 9

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By J. L. Replogle

—

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By J. A. Carney

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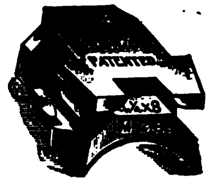

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